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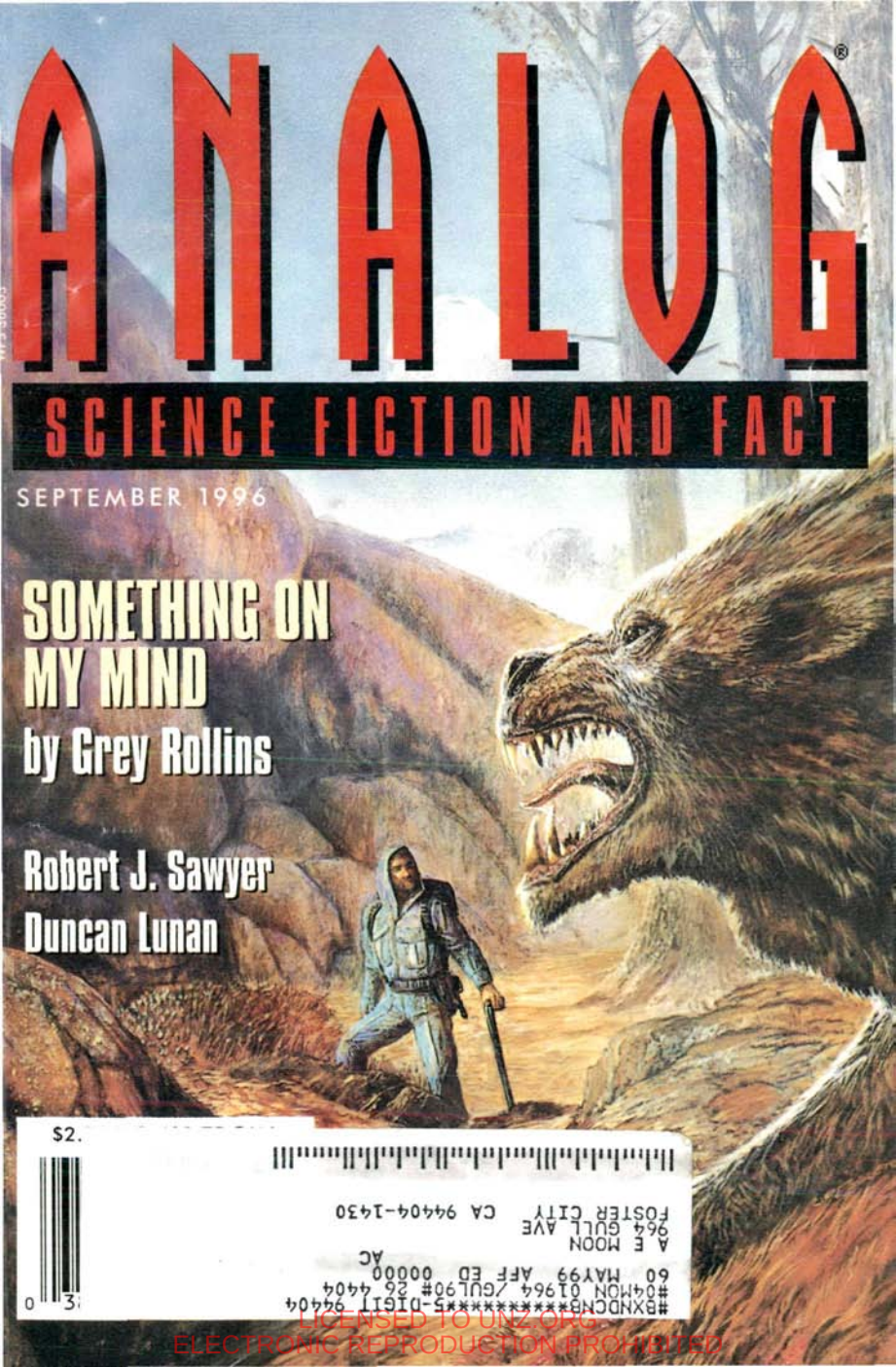

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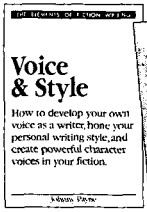
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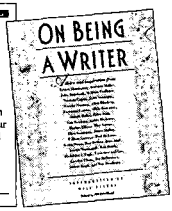

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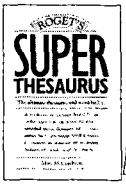

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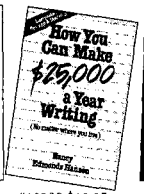

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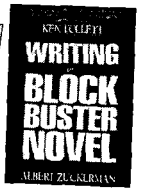

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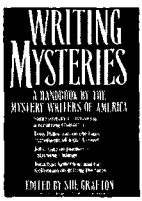

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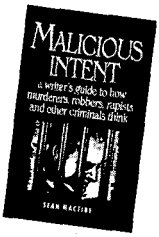

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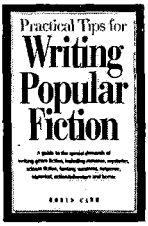

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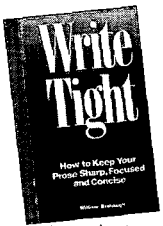

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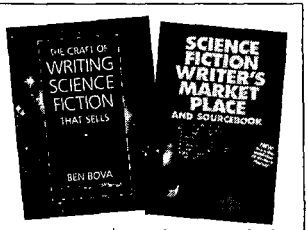

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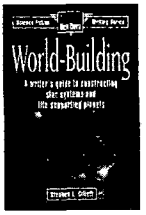

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I/O

Back in August of 1992, *Analog* published Michael F. Flynn's haunting story "Captive Dreams," about a young boy who was obviously retarded—but in a far more literal way than anyone first suspected. The thinking part of his brain was as good as anybody's; his problem was that his "input/output buffer kept getting backed up," so that most of his sensory inputs reached his brain seconds after the stimuli that produced them. Thus his responses were usually inappropriate, and the feedback he got from them merely added to his confusion. He would, for example, reach for a whirling pinwheel he'd seen, but his hand would close on the empty air from which it had since been moved.

It's not enough to know information, or to know how to process it. To *use* it, you also have to be able to get it to and from the outside world by appropriate channels and on an appropriate time scale.

Flynn's story was by no means the first science fiction to deal with ideas about input and output and their importance to the human nervous system. Many stories have dealt with things like direct brain-computer interfaces: implants that give everyone instant access to the equivalent of huge libraries, for example, or war machines whose control centers are built-in human brains.

Nor are such concerns confined to science fiction. In the real world as we have already experienced it, many stroke victims have experienced the frustration of knowing what they want to say or do and being unable to act on the desire or communicate it to those around them. Those who have lost one sense, such as sight or hearing, must learn to compensate by getting information through other channels more efficiently than most of us need to. Autism and dyslexia are disorders in the way a brain interfaces with the outside world.

In fact, concerns about input and output are confined to neither fiction nor pathology. Getting information to and from a person's central processor plays a key role in virtually every aspect of normal living.

Using language, for instance. I used to think I could learn a language from a book, and to a certain extent, I can. But even if I've learned enough from books to be able to read a newspaper or magazine rather fluently, the first times I attempt conversation—speaking and understanding real people speaking normally—are likely to be

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humbling experiences. Knowing *how* to speak a language is not the same as being *able* to speak it.

Apparently what happens is something like this. If you study a language entirely by reading books and writing exercises, you establish neural circuitry that directly associates written words brought in by your eyes, or sent out by your hands, with meanings and grammatical structures in your brain. You may know how to pronounce all the words, but if you haven't similarly developed direct neural linkages between your brain and your mouth or ears, you'll have to translate everything you hear into its written form before you can understand it.[1] Real conversation doesn't allow time for that, so conversation can be hard even if reading and writing are easy. Similarly, the "total immersion" approach to language teaching trains *only* the conversational linkages, and doesn't guarantee proficiency in reading or writing. Probably the best way to learn a language is one that uses *all* available channels. That not only provides the whole set of useful skills, but likely speeds the firming up of the "CPU" circuits that think in the language, by letting the various channels reinforce each other through cross-linkages.

Other examples of the importance of neural input and output mechanisms abound. In music, knowing how to play an instrument is not the same as being able to play it well. A high school band director must know how to play all instruments in his group—he must be able to answer a clarinetist who doesn't remember a fingering, or a trombonist a slide position—but may actually be proficient on only a small number of them. Knowing fingerings and positions merely involves storing data, which, for question-answering purposes, can be accessed in a relatively slow and clunky fashion. *Playing* fluently requires a direct link from brain to mouth and fingers.[2]

As a writer, I not uncommonly find myself getting so close to a deadline that I *must* start writing a piece even though I don't feel ready to. That is, if

1. Please note that I *didn't* say you must translate everything into your *native* language, as too many poorly taught language courses allow or even encourage you to do. To learn a language well, you must train groups of nerves to directly associate symbols in that language with their meanings. But the nerves that associate *written* symbols with their meanings are not the same ones that associate *spoken* symbols with their meanings!

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I try to talk or think ("talk silently to myself") about what I'm going to say, I don't seem to have a clear enough idea of what that's going to be. If I start trying to put something on paper or disk anyway, because I have to, I'm often surprised at how easily the ideas flow and how well developed they are. Evidently the creative part of my mind (which functions largely at a subconscious level) has already done more work than I realized, but its "hot line" to my keyboard fingers is much better developed than its connection to my other output devices. (I suspect this implies that I would find writing by talking into a tape recorder, as some writers prefer, awkward and frustrating—until I trained a new output system.)

Speaking of keyboards, I sometimes find myself called upon to explain to someone else how to do something unfamiliar to them on a computer. Even if the operation in question is something I can do quite easily, I'm always amazed at how much harder it is to talk someone else through it than to sit down at the keyboard and do it myself. Here again, I've evidently trained neural circuitry that directly translates thoughts into finger motions. Translating them instead into verbal descriptions of those finger motions is an extra and, it would seem, a surprisingly roundabout and cumbersome process.

Slower, of course, is not always, necessarily, or intrinsically *worse*. Sometimes speed is important and sometimes it isn't. I'm not sure whether it was really Albert Einstein who first said, "Never learn what you can look up," but I wouldn't put it past him. Whether he did or not, cer-

2. Some players must even train several *different* sets of linkages. For complicated historical reasons, orchestral trumpet and horn parts are often written in a different key than the one in which they must be played—and the way in which they differ is not always the same. Thus trumpeters and hornists must learn to transpose in several different ways, and a player who has to consciously think about how to transpose each note will not be able to keep up.

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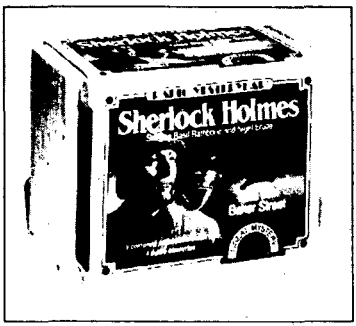

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tainly many others have—including me, on occasion. It's quite appropriate for some circumstances, but not all. There's not much point in cluttering your personal memory with lots of detailed facts that you'll need only occasionally, if ever. For most of us, for example, it would make no sense to memorize the density of water to six decimal places at every temperature between freezing and boiling. If you ever need to know it at a particular temperature, you can look it up; and you probably *won't* ever need to know it at most temperatures. If you're working on a refinement of theory for which the detailed way the density varies with temperature is crucial, you will likely become very familiar with the shape of the curve, and you will at some time need to know a goodly number of precise values. But you probably *won't* have to carry them all around at your mental fingertips. New scientific theories are rarely needed or expected on a moment's notice, and good ones are worth waiting for.

On the other hand, some things *do* need to be at your mental fingertips. To speak a language fluently, you *cannot* take time to look up every word and grammatical rule you need to construct a sentence like, "Jump away from there before that safe lands!" To play fast passages on an oboe or violin, not only can you not take time to look up the fingering of each note, you can't even take time to think about what each note *is*. Not only must the meaning of each note on the printed staff be at your mental fingertips, but your mental fingertips must be connected as directly as possible to your physical fingertips. To fly safely from New York to Los Angeles, you would not want to depend on a pilot who has to look up the procedure for increasing his plane's airspeed, or what the airspeed should be for a particular maneuver.

All of which implies, by the way (and appropriately to the season), that if you want to test how well someone has learned something, a truly meaningful test must require them to output the data in a way as close as possible to the one they'll use in a "real-life" situation. A written multiple-choice test on bassoon fingerings or how to land an airplane may demonstrate presence or absence of knowledge needed for those tasks, but it *cannot* prove *competence* in them. The only way to do that is to require the ~~victim~~ student to play a challenging bassoon solo or land an airplane safely.

Come to think of it, how many "real-life" situations can you think of in which information *is* accessed and outputted in any way resembling a multiple-choice test?

Maybe it's time for people who really want to improve education to be paying a lot more attention to the detailed neurophysiology of input and output systems, not only for designing more meaningful tests, but for finding more effective ways to get information stored durably and accessibly. Much discussion of education concerns *what* should be taught. We also hear lots of advocacy of this or that teaching method, some of which catch on enough to become fads for a

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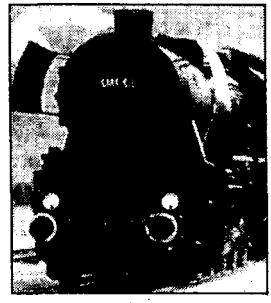

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while; but in my experience, most of the "revolutionary improved methods" are based far more on somebody's hunch or wishful thinking than on any actual knowledge of the mechanisms involved. It may be that to effect much improvement in education, more attention needs to be given to the nitty-gritty of how knowledge gets in, and how it will have to come back out. ■

IN TIMES TO COME

As you've probably already noticed, Robert J. Sawyer's serial *Starplex* practically demands a second cover for its conclusion. Jim Burns has obligingly provided one for our October issue, and I think you'll be pleased with how both he and Sawyer wrap this story up. Despite the ever-widening scope of the novel, it not only ties everything (and I mean *everything!*) neatly together, but incidentally suggests answers to some of the biggest questions now facing several breeds of scientist!

Other fiction highlights include H. G. Stratmann's "Symphony in a Minor Key," a thought-provoking novella that gives new meaning to a well-worn old saw. Anything that can be used for one purpose can, after all, be used for others, too. . . . Jerry Oltion has a slightly outrageous little something for the season, and I suppose Rick Shelley's sneaky "State of the Union" could also be considered seasonally appropriate, in a completely different way.

Finally, Ian Randal Strock returns to *Analog* with a fact article so timely that the change it deals with is already upon us. But it's still new enough to allow some time for thinking about how far, and in what direction, we want it to go. . . .

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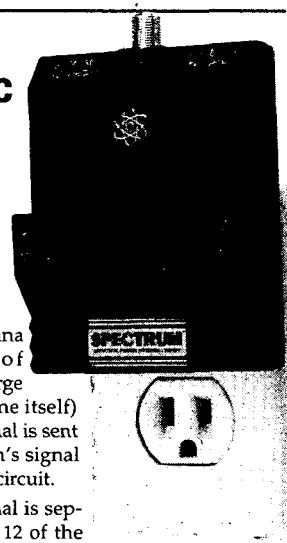

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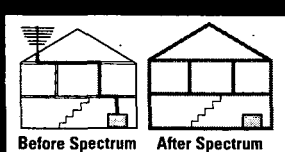

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Grey Rollins

SOMETHING ON MY MIND

A fundamentally new ability might open a new kind of ecological niche. . . .

Illustration by Nicholas Jainschigg

Mid-morning, early summer. A stiff, dry breeze blew across the exposed face of the hill. The movement of the air neatly counterbalanced the rising heat.

Behind me was a broad, round-bottomed, glacial valley, filled with the local equivalent of trees—almost exactly like trees, except for an internal skeleton of something about the consistency of cartilage. Before me, written in the naked rock, was a tale of unimagin-

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able power and violence. The country rock had been rent by the salt-and-pepper glitter of intrusive dikes of a fine-grained pegmatite. Long, forking lines reached across the barren side of the hill like lightning etched on a gray stony sky.

Ascendance was the ninth habitable planet discovered by humans. I and my co-workers were an advance team, here to explore prospective sites for settlements and to get some rudimentary infrastructure in place before the colonists arrived.

My contribution consisted of identifying the gross geologic features and trying to find any obvious, easily accessible deposits of minerals. So far, I had found traces of iron, no more. Pegmatites often yield other riches, such as radioactives, so I was still hopeful.

The wind backed, shifted, and whipped dust into my eyes and mouth. The pain was sudden and intense. I stumbled backwards, simultaneously pawing at my eyes and spitting grit.

Naturally, my radio picked that moment to announce a call. Just as inevitably, I had left it on my pack a good ten meters away.

Cursing in a steady stream, I fumbled blindly, as much by sound as sight. It took an eternity to find the idiot thing. I sat heavily next to my pack, picked the radio up and said, "Stills here."

It was Susan Blankenship, back at the camp. "Have you seen Mike?"

"Nobody out here but me and the dust devils."

"Cut it out. I'm serious."

"Cut what out? He's not here."

Susan sighed heavily, as though having to talk to me was the worst kind of imposition. "Listen, smartass, I asked you if Mike was out there."

"Mike's not here. What could be simpler?"

There was a lengthy pause during which I imagined her counting to ten. Judging from the tone in her voice, I had managed to irritate her again. This seemed to be a special talent I alone possessed. As far as I knew, I was the only person, man or woman, who could anger her just by the way I held my fork.

Her voice, when it came back, was clipped and curt. "Where are you?"

"I'm on the far side of Bareback Ridge, about even with the fork in the stream."

"And you haven't seen Mike?"

"No, Susan, I haven't seen Mike. Not since breakfast."

"Not at all?"

My turn to count to ten. "What's wrong, dearie, did he-man leave his loincloth behind again?"

There was an abrupt click.

"Susan?"

No reply.

I shrugged. I wouldn't miss talking to her, but now my curiosity was stirring. Obviously, Susan had misplaced Mike Gaston. Since they were an item, she would be quick to worry. On the other hand, Mike was quite capable of taking care of himself.

Still, complacency can kill you, and no place more easily than on a new world. I blinked sore eyes experimentally a couple of times, then stood and made my way to the top of the ridge,

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the better to see. Five minutes of fruitless scanning through my binoculars reinforced my impression that I was alone.

I keyed my radio and said, "Susan, this is Heath, I'm on top of Bareback now, and I still don't see Mike. Is this an emergency? Should I drop what I'm doing and look for him?"

The sun beat down on my shoulders as I waited for a reply. Minutes passed. I heard a wallah calling down in the valley below me. *Wall-ah, wall-ah, wall-ahh!* I shrugged again and gave up, slipping my radio into my shirt pocket to free my hands for the descent back to where I had left my pack.

The radio beeped. I pulled it back out and keyed it. "Stills here."

"Did I *say* it was an emergency?" Susan demanded querulously. "No! So go on back to whatever you were doing. I'm sure your rocks are waiting on you."

"That they are, my dear. Millions of years, they've waited, and I'd hate to keep them waiting another minute. Stills out."

As I slipped and skidded back down to my pack, I saw the wallah at the edge of the trees below me. Partly arboreal, they were nimble climbers, but not much else. In size and shape, they resembled a cross between some of the smaller Earthly primates and a koala, but appeared to be scavengers, eating the remains of kills made by other animals.

By the time I got to my pack I was mildly winded. I squatted on my heels and took a sip from my canteen, swirled it through my mouth, then spat. That took care of the remaining grit in my mouth, but my eyes still smarted. Not much I could do there.

Why hadn't Susan simply queried Mike's radio? There was a communications satellite in synchronous orbit that would report back to her in seconds. Presumably, Mike's radio would be somewhere near Mike, and her question would be answered.

That left two possibilities. One, hopefully the most likely, was that Mike had simply turned his radio off. It wasn't unlikely. If your radio was queried, it beeped so you would know that someone was looking for you. Mike, in his role as biologist, could easily be trying to stalk an animal. The beep would ruin his approach. The other, more ominous, possibility was that the radio had been destroyed, but if Susan didn't think there was any reason to worry, then I wasn't going to pursue that train of thought.

Mike turned up safe and sound. I saw him that evening at supper with Susan almost literally hanging on his arm. I wouldn't have thought anything more about it had I not seen him trade a significant glance with Gilda Orr.

That raised a third possibility—that Susan simply hadn't liked what Mike's radio had been telling her.

The next day, I did something I didn't normally do. I took my rifle with me when I went out into the field. Even if it had been prompted by jealousy, Susan's call the previous day had spooked me a bit. No one had ever been attacked by the local fauna, but I had gotten complacent. Not good.

I resented the weight of the gun,

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and I resented the bulk, or at least the length of it. It snagged on branches and tangled in every vine. I was all but ready to sling the damned thing into the brush by the time I got back to the far side of Bareback Ridge. I just hadn't quite come up with a plausible story about how I had managed to lose it, especially as I was known to be almost neurotically careful with my equipment.

I had no ideological quarrel with carrying a weapon. It's the futility of it that galled me; I'm a terrible shot. The inborn ease with which Mike Gaston could swing a rifle to his shoulder and effortlessly place small holes in a tight pattern on a target I could barely see was forever beyond me. Should the need to defend myself arise, I would be more likely to shoot myself and save a predator the effort of pulling me down.

I carefully placed the gun on the ground, half-afraid it would fire if I looked at it wrong. I then shrugged out of my pack and placed it next to the gun. After a few minutes of rest to get my breathing back in line, I started working my way up one of the dikes.

Small black crystals of magnetite, but not in sufficient quantity to be useful as iron ore. Pale blue hexagonal prisms of apatite. Pretty, but not really useful. Then a stretch where I saw nothing but the mica, quartz, and feldspar that made up the pegmatite. Each useful enough in its own way, but not worth getting excited about.

Wall-ah, wall-ah, wall-ahhh!

I turned and looked. Sure enough, there he was, just at the edge of the trees down below me. The wallah looked directly at me, then sprang across to another tree, then to another, then turned and went deeper into the forest before I lost sight of him.

I went back to my work. More of the tiny octahedrons of magnetite, not much more than grains, really. A nice, perfectly formed crystal of mica. Worthless, in and of itself, but a museum on Earth would pay a small fortune for it, just because it came from Ascendance. Only problem was, there was no practical way for me to get it back to Earth.

The crashing of an animal—a large animal—at a full run. Getting closer. I spun and stared down at the tree line below me. Nothing, but now I could hear the animal snorting and heaving for breath as it ran.

Was it running from something . . . or towards me? And if it was running from something, what the hell was it running *from?*

I glanced at the rifle, then back . . . *there* . . . a flashing glimpse of reddish brown between the trees, and then it was hurtling straight up the hillside towards me. Large, powerful shoulders and bared teeth. Head lowered, hooves sounding a staccato beat on the bare rock.

I broke and ran, in the long-legged lope that people use running down shallow slopes. In the back of my mind a little voice awoke, chastising me for not having practiced more with the gun. Too late now.

I skidded to a stop just below my pack, made a long reach for the rifle, swung the ungainly thing around, pointed the barrel towards the oncom-

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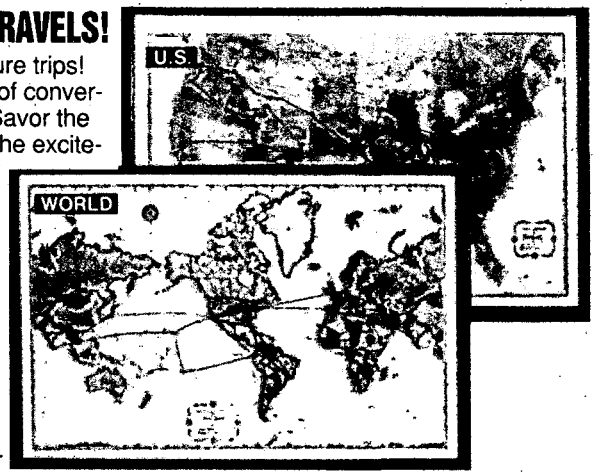

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ing beast, and groped for the trigger.

Being a laser, there was no sound or recoil, but the creature's legs buckled and its chin plowed into the stone face of the hill. I watched the animal collapse in on itself, seemingly in slow motion. It rolled over once, more due to the slope of the hill than volition, and was still.

I looked in amazement at the rifle, then at the dead beast, then back at the rifle. Then allowed myself to breathe again.

Ha! The secret. In my fear, I had done the very thing I had been told to do when shown how to operate the rifle: Hold your breath, it will make your aim steadier.

I placed the gun across my knees and sat looking at the mound of fur. It wasn't something I recognized, but that didn't mean anything. The entire planet was populated with things I wouldn't recognize if they walked up and introduced themselves.

Was it dead, or merely wounded? It lay absolutely motionless. I groped behind me until I found the radio, unwilling to let my eyes leave the creature until I was certain that it wouldn't drag itself to its feet and resume its charge.

"Base?" I started, trying to keep my voice steady.

It took a few seconds, but the reply came back. "Heath? You OK? You never call in this early."

"Gilda? Yeah, I'm all right. At least I think I am, but there's a big critter here I think someone ought to come take a look at. It charged me."

"*Charged* you?" Everybody's nightmare—something aggressive and big. She didn't like what she was hearing. I could sympathize.

"Ran. Hard. Towards me. Scared the ever-living hell out of me."

"What is it? Where is it now?" she asked.

"I don't know what it is, but it's right here in front of me . . . uh, Bareback Ridge. Other side."

"In front of you? It stopped? Are you up a tree, or what?"

"I killed it."

"You *what?*"

Honestly, I didn't blame her for being startled. My lack of prowess with a gun was widely known.

"I shot it. It's dead. Well, it looks dead, anyway. I'm going to keep an eye on it, just to be sure."

There was stunned silence for a few moments. "I'll get somebody up there right away."

"I'd appreciate that. Oh . . . Gilda?"

"Yes?"

"Tell them to hurry if they want a good look at this thing. I've got a wallah up here who seems to think it's dinner time."

Mike Gaston was, perhaps inevitably, first on the scene, followed shortly by George Evanston and Mia Sands. Mike landed his skitter at the top of the ridge and hopped out, immediately taking possession of the area for God and king just by planting his feet at shoulder width. He danced down the ridge as lightly as though he had done it thousands of times. In fact, I don't think he had ever been there before—bare rock just didn't interest him.

George and Mia were a little more cautious, circling the area once before landing their skitter next to Mike's.

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They were slower to approach, too, stepping warily down the hillside. Like me, they acted as though the beast might spring back to life.

Mike squinted at the carcass as though interested, not in the animal itself, but in the details of its demise. "It charged you?"

I nodded.

"I hope you didn't pay too much."

It took me a moment to get it. I gave him a shaky grin.

"You shot it?"

I nodded.

"It's still intact."

"I think so. I only fired once."

"Not continuous beam?" he asked, as though probing for a confession. Like Gilda, he didn't have much confidence in my marksmanship. A continuous beam would have allowed me to slash, slicing the thing in half—requiring little in the way of aim.

I gestured. "Have a look."

He walked confidently towards the body as though it was no more hazardous than a leaf. I safetied the rifle just as George and Mia walked up. They asked almost the same questions as Mike, so I repeated the same answers. They, like Mike, seemed politely skeptical that I could have brought the animal down with a single shot.

Well, so was I.

Mike stopped about three meters away from the animal. The wallah eyed him warily, then resumed worrying a strip of hide off of the body. Without warning, Mike suddenly stomped his foot and waved his arms, shouting.

"Wah—!" the wallah shrieked, scampering towards the trees, dragging the strip of flesh with it.

Mike circled the body, then squatted near the head. He looked up at me, frowning, then back at the head, then back at me. "One shot, between the eyes," he called.

As if his words were a signal, George and Mia started towards the body. Mia surveyed the animal, then, like Mike, she glanced back towards me, an appraising look.

After ten minutes and much discussion of dentition, jaw structure, musculature, and eye placement, they came to a consensus. It was omnivorous. As such it could conceivably have been a threat. Mike took pictures and a tissue sample, then left the carcass where it lay and came back to stand before me. George and Mia took up flanking positions behind him.

"That was a lucky shot, Heath. I'll log it in and let the sequencer rebuild it from the DNA. Once we've got a model, we can take a closer look at the morphology and see what we've got."

I sat quite still for a long time after their skitters left, just looking at the fallen creature. A strange mixture of feelings was running through me. Regret and shame for having killed a living being, no matter how alien. Pride in my hitherto unsuspected marksmanship. Residual fear, left over from having a wild animal, possibly a dangerous one, come charging at me. A primitive urge to beat my breast and yodel at the silent forest that I was a man, able to take care of myself.

After a while, I pushed myself to my feet. Below me, the wallah was edging its way back up the slope, staring hungrily at the carcass.

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* * *

I quit early that afternoon and hiked back to our base camp. I was hungry and tired when I walked out of the trees and saw the neat rows of temporary shelters. It was a welcome sight. Gilda came rushing out of the one that served as our command post and slammed into me, wrapping me tightly in her arms. "I'm glad you're safe."

Although by my standards Gilda was a very attractive woman, not once had she ever shown me the slightest bit of warmth, so I didn't know how to react to this. "I'm all right. Honest."

"I was worried," she said, leaning back to look up at me.

"So was I," I admitted truthfully.

She seemed to think it was a joke. She dimpled. "Oh, *sure* you were. I heard about how you nailed that guy right between the eyes."

"I got lucky."

She squeezed me, hard, then released me just as Adam Anderson, the leader of our team, walked up.

"Are you all right?" he asked.

"Sure, I'm fine. The worst part was having to work that part of Bareback Ridge with a dead animal twenty meters away."

He grinned. "Look, if you're not too tired, I'd like for you to give us a report on what you've found out there so far . . . other than the creature, I mean."

I shrugged. "Sure."

We were on rotation. About once every three or four weeks, we would give a report on what we had discovered. In theory, it was to promote some kind of cross-fertilization of ideas among the various disciplines. In reality it was a subtly disguised popularity contest. Few, if any, people attended the talks by those who were "out," whereas those who were "in" could count on a lively crowd to discuss their findings. I never counted on more than two or three people when it was my turn. Sometimes I simply waited ten minutes to see if anyone showed up, then went about my business.

After talking to Adam, I turned to go back to the small hut I lived in, but stopped when I heard Gilda's voice behind me. "Care for some company?"

That froze me in my tracks. Facing down a wild animal is nothing. True courage is not panicking when an attractive woman seeks you out.

I swallowed hard in a suddenly dry throat. "Um . . . sure."

She fell into step beside me. We walked slowly. After standing outside the door of my hut talking for twenty minutes, I ducked inside and retrieved two chairs. We sat watching everyone else straggle in from their various researches out in the field until time to eat.

For all the sugar in orbit, I couldn't tell you what we talked about, but I had more fun talking about it than I had had in ages.

What was even better was the quick peck on the cheek she gave me later on that evening. Maybe it was less than Mike Gaston would have gotten, but it was enough to make me grin like a fool.

Eighteen people showed up for my report that night, a personal record, but I was not surprised when it dwin-

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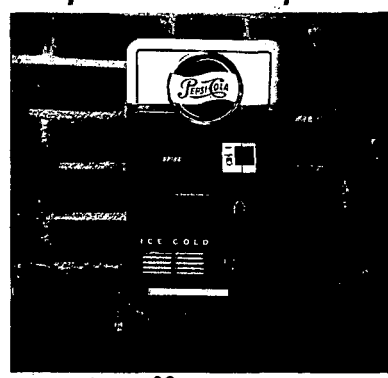

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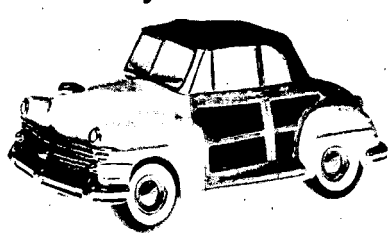

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dled to seven the next time, then four. Nor was it surprising that they peppered me with questions, not about the magnetite, but about the beast I had shot.

Still, it stung that I was forgotten so quickly.

Two more lasting things did come of the incident. The first was that I started carrying the rifle with me every time I went out into the field. The other was that Gilda began to speak to me. Mike Gaston was still very much in the picture, yet she began saying hello, asking me how my day had gone. Not wanting to run afoul of Mike, I did nothing to encourage her, but I certainly didn't go out of my way to dissuade her, either.

Honestly? Aside from the possibility of conflict with Mike, I was afraid of rejection, but I wouldn't admit that, even to myself.

Perhaps strange things happen to a man who works alone all day. I began to think of the wallah at Bareback Ridge as a pet. I'd never owned a pet in my life. Never felt the urge. But if I didn't see the silly little thing at least once during the course of the day, I'd fret a bit.

The barren flank of Bareback Ridge stretched for quite some ways. I worked that rock to death, dallying much longer in the area than I had originally planned, just so I could have company—even if it was an alien scavenger.

Mike had begun to be peripherally aware of me after I killed the creature. Before, I had been safely anonymous. Now, I was a player, albeit a very weak one. Whenever he happened to see Gilda talking to me, he'd always make a point of coming over, pumping my hand and asking me how I was doing. He'd talk animatedly for a few minutes, then somehow Gilda would end up leaving with him, often without bothering to say good-bye. The clincher? If Gilda wasn't talking to me, Mike didn't even glance my way. I'd have given a shiny penny to know what Susan thought of his behavior. Not that I ever wasted my time asking.

But the wallah was mine. At least until Mike found out. He'd probably do something obnoxious like stand on the edge of the woods and imitate its call . . . *Wall-ah!* Within ten minutes, it'd be eating out of his hand and riding his shoulder, nuzzling his ear. And that would be the end of my pet wallah. From then on, it would be Mike Gaston's pet wallah, and all the women would coo and vie for a chance to rub its fuzzy little ears. So I kept my pet a secret.

My rifle began seeing regular use. I used it to feed the wallah. Not only was I feeding my pet, but it was good target practice. Game was always plentiful—frequently right at the edge of the trees, almost on display. Something or other would pop up within shooting range within five or ten minutes of my arrival at the ridge. I'd shoot it, and generally, if it wasn't already watching from the safety of a nearby tree, the wallah was there within a few minutes.

It couldn't last forever, of course. I had other places I needed to be. But I kept prolonging my inspection of Bareback Ridge. The wallah moved

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down the ridge with me, a matter of nearly four kilometers before all was said and done. Whether the critter was commuting to and from a fixed nest or migrating along with me, I couldn't say.

On the last day, I shot a Wilson's squirrel-cat, then went and sat about three meters from the carcass. I had already seen the wallah, bouncing from tree to tree, and I knew that it had seen me. It clung to the side of a tree not far away, eyeing breakfast. After about ten minutes, it came down and started padding towards me, walking upright with a bowlegged gait—almost a swagger—that I had never seen it use before.

It kept an eye on me, but I'd be hard pressed to say that it was being wary. It didn't act the least bit skittish. It fell to eating and gave up watching me entirely. After a bit, it sat up on its haunches, staring me in the eye, then turned and walked into the forest.

The next day, I shifted to the south face of Tea Kettle Dome, over five klicks away.

If Bareback Ridge had been a waste of time, Tea Kettle Dome was not. A small trickle of water that bounced and slid down off the side had a tendency to leave green stains on the rock. I started up the side of the hill, hacking my way through the dense undergrowth with a machete, following the water up the slope, adding my dripping sweat to the rivulet. About two-thirds of the way up, my foot snagged in a vine and I tried to drill a hole in the hillside with my nose. I managed to get my arm up in time and my elbow took the brunt of the impact. Better than my nose, perhaps, but the pain was excruciating. I lay just as I had fallen, cursing in a monotonous monotone which did nothing to lessen the agony.

When the worst of it had subsided, I rolled onto my side, still breathing heavily. Before my face was a roughly triangular area where I had scuffed the thin dirt when I fell. I could see the ribs of the mountain. Translucent quartz, stained deep blue-green.

Oh, boy.

Within an hour, I had found enough malachite and azurite, both secondary weathering products of copper ores, to convince me that Tea Kettle Dome was going to figure prominently in the colonists' future.

I spent the rest of the afternoon collecting specimens, ranging up and down the slopes, more excited than I'd been since I'd visited my first mine dump as a boy of ten. My pack grew heavy, pregnant with samples. I left it and the gun and clambered across the side of the hill, determined to find a crystalline specimen; all I'd found so far were masses. Finally, just at dusk, I cracked open a pitted mass of quartz the size of my head and found the tiny radiating hair-like crystals I'd been seeking all day.

It was long after dark when I got back to camp.

As I trudged up to the gate, I could see a solitary figure pacing just inside the fence.

Gilda.

I forgot myself. I ran towards her, gun and pack banging against my back, and caught her in my arms.

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"Heath?" she gasped, startled.

"I'm the man of the hour, my dear!" I exulted. "At long last, I have earned my keep on this damned expedition!"

"God, you terrified me! I didn't know what had happened to you. I thought—" She broke off in mid-sentence, seized me by the ears, and pulled my face down into the kiss that I had been fantasizing about for the last three months. "Don't you *ever* do that again! I don't care if you're the man of the *year!* When I call you on that radio, you answer me, understand?"

"Radio?"

She gave me a look that seemed to indicate that she thought that I had been born with substandard mental powers. "Yes, radio, Heath. A small electronic device intended for communications. Something I was glued to throughout the afternoon. Something I have here in my hand, hoping that you would call in so I would know where you were—so I could come rescue your broken body, if need be. In case you don't get the message, idiot, I was worried sick about you! I don't know whether to hit you or kiss you."

"Actually, if you're offering me a choice, I—"

This time we didn't come up for air for quite some time. Just as I was beginning to fear anoxia, she pulled back and said, "All right. So you're alive and well after all. I'll get around to forgiving you next Friday. Put it in your appointment book. Now, what is it that's made you so smug?"

I started telling her about the copper on Tea Kettle Dome.

"Tea Kettle? *Tea Kettle?* You didn't tell anyone you were going to Tea Kettle! We all thought you were out on Bareback!"

She called me more names and threatened me with dire consequences. "*Oooh,* I'm so mad at you!" she said finally, stamping her foot.

"I'm sorry," I said. "I didn't know you cared."

"Didn't know . . . " she began, then subsided, shaking her head. "*Men!* It's a wonder the species has survived this long! If it weren't for women throwing themselves at men, we wouldn't be here."

Try as I might, I couldn't think of a single instance where Gilda had thrown anything, much less herself, at me. But the implications of what she had said. . . .

"So why didn't you answer your radio?" she demanded. "Are you too important to talk to us normal people now that you've found green rocks?"

I was saved from having to compose a reply by the arrival of Adam Anderson. He went through the same sequence of fussing at me for not answering my radio, demanding to know if I was still in one piece, fussing at me for not answering my radio, wanting to know where I'd been, fussing at me for not answering my radio, listening to the first ten words of my description of the copper, fussing . . . after the tenth time, it finally sunk in.

"Wait a minute, wait a minute!" I yelled, in order to override the increasing noise level—others had begun to gather, drawn by the commotion. I reached into my pack, drawing out my radio. In the wash of light from the floodlight at the command hut I could see that the switch was in the off posi-

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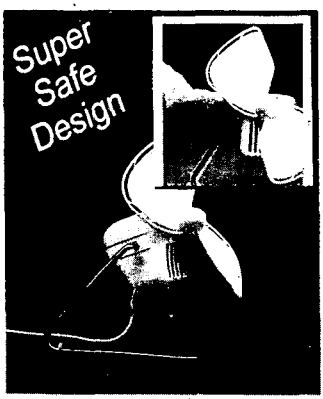

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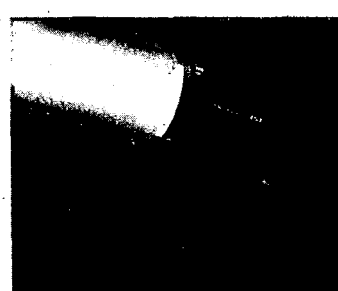

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tion. "Mystery solved!" I said, holding the radio aloft. "It's turned off."

"Jeez, smarty, couldn't you figure out how to turn it on?" came a voice from the back of the small crowd.

Gilda chimed in. "You knew you were late coming back. Couldn't you have called to let me know you were all right?"

"OK, OK. I was bad. I didn't tell anyone I was going to Tea Kettle, my radio was off—why, I don't know, unless it got switched off when I fell, and I didn't call home when I knew I was running late. Go ahead, make me eat worms. *But!* Don't do it until you see how much copper there is out there. Surface indications are that there's quite a bit. If the formation is as big as I'm hoping, the colonists will have a useful product as soon as they arrive."

Adam congratulated me. "What will you need to check this out?"

I thought for a second, then told him I'd like a skitter to haul the coring drill and some other odds and ends out into the field. Without thinking, I also added that it would be nice to

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have a little help. Although I could do it myself, it would go much faster if I had someone along.

Almost before the words were out of my mouth, Gilda piped up. "I'll go," she volunteered. "I'm caught up on my lab work."

He looked from her to me. "Well?"

I wasn't sure I trusted myself to speak. "Uh . . . sure. I'd love to have her along."

After that, the crowd dissipated. Mike Gaston had apparently been among those listening in on the exchange, although I hadn't seen him walk up. Gilda saw him at the same instant I did. She made a show of slipping her arm through mine. A look passed between them that has no name, but there was an element of defiance about Gilda as she walked off with me, chattering gaily, leaving Mike staring after us.

The expression on his face was not pleasant.

The ride out to Tea Kettle the next morning was pure bliss. Gilda and I had started early, and the sun had just cleared the horizon as we skimmed above the tree tops.

A skitter is like an oversized pickup truck with wings and a retractable roof. It being summer, I had the top down. The wind of our passage whipped Gilda's hair as I slalomed between the hills, following the stream bed rather than flying higher and taking the direct route.

"*This* time, I'll know where you are," Gilda told me. "Even if you do come back late."

I grinned in response. "I suppose this is as good a time as any to tell you that I packed a picnic."

"Lunch?"

"Well, that too. But what I had in mind was dinner, actually." I glanced at her. "I even brought a candle."

Her eyebrow raised. "Why, Heath, if I didn't know better, I'd say you just revealed a romantic streak. Perhaps I'd better do a little prospecting to see how deep the vein goes. It might be worth mining."

I banked the skitter into a tight circle, whooping at the top of my lungs, just to let off steam and let the world know that I was happy.

Gilda turned out to be an excellent partner. Her lab work had made her a stickler for detail—a useful trait to have when working with a laser capable of punching a hole the size of your fist into solid rock.

Basically the laser moved in a five centimeter track on top of a tripod, round and round, burning a circular hole into the ground. When it was done, the laser head swung aside and an electric winch lifted the heavy core out. By lunch, we had three short but decent ones from holes spaced across the base of the hill.

I spent lunch wiping the sweat out of my eyes, but I didn't care. Gilda was laughing at everything I said and I felt like a claustrophobic genie who'd just popped out of a thousand year confinement in a lamp two sizes too small.

Late that afternoon, we carefully laid the last section of the last core on the ground. "Now . . . about that candle-lit dinner. . . . " Gilda prompted.

"Did I mention a beautiful sunset?"

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She glanced over her shoulder at the oranges and reds condensing on the horizon, then turned back to me, smiling. "No, I don't believe you did."

I shrugged. "Just figured I'd toss that in for good measure. I only wish I'd thought to bring a portable shower."

"What's wrong with the stream?"

"I—"

"Shy?"

So what do you do in the face of a challenge like that?

It took a while for us to finally get around to eating. First I scrubbed her back, then she scrubbed mine. Then for a while we forgot all about scrubbing, although there was a great deal of motion involved. Then we got back to washing, but in a more leisurely manner. We even rinsed out our clothing and left it on a rock to dry.

Feeling self-conscious, I called in. "Um, this is Heath. We got caught up in our drilling and we'll be a bit late getting in."

"Got any idea how much longer you'll be?" Adam asked.

"Oh, I'd say we'll be along in an hour or two."

He snorted good-naturedly. "You might as well spend the night."

"Nah, didn't bring a sleeping bag."

"Well, all right. Just let us know if you get in trouble."

After I put the radio back in the skitter, Gilda said, "Caught up in our drilling? A bit risqué, don't you think?"

Honestly, I hadn't meant anything by it, but if she thought I was being clever, I wasn't going to say otherwise. "Woman, you have a dirty mind."

She looked down at her nude body. "Better than a dirty body."

"*Much* better," I agreed emphatically.

Although the food was simple, I enjoyed myself immensely. After we finished we walked down to the stream, hand in hand, to retrieve our still-damp clothing. We left the corer and puttered back to camp.

Although he wasn't waiting by the gate, Mike Gaston was standing in the open door of the command hut, watching us. His face was in shadow, but I got the impression that he was scowling.

At the moment, I couldn't summon up anything but a smug grin. I'm sure that didn't help matters any.

The next day was a near replay of the first. I hadn't had the wit to think of it, but Gilda brought along towels, shampoo, and a fresh change of clothing. Seeing her standing there in the middle of a forest on an alien planet did strange things to me. I started thinking about the fact that the colonists would need a geologist. That it would be nice to settle down. That....

OK, OK—but it made a pleasant fantasy.

As I was cooking our dinner, I heard a distant *Wall-ah, Wall-ah, Wall-ahhh.* I straightened up. *Wall-ah.* It sounded fainter.

I cupped my hands to my mouth. "*Wall-ah!*" I cried.

Gilda, startled, looked at me. "Should I call you Tarzan or Doctor Doolittle?"

I looked down at my clean though unclad body. "I'm a little underdressed for Doolittle, don't you think?"

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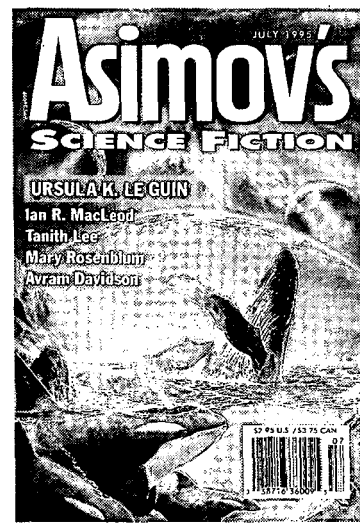

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She gave me a head to toe appraisal. "Somewhat less than the usual Tarzan garb, for that matter."

Wall-ah!

"Wall-ah!" I answered.

"Seriously, why are you talking to a wallah?" she asked.

I told her about my secret pet over at Bareback Ridge.

"Did you ever talk to it?"

I shook my head. "No. But if there's another one around here, it wouldn't hurt to be sociable."

Her gaze drifted out into the trees. "Maybe it's the same one. It sounds as though it's coming from the general direction of Bareback Ridge. Did you tell it where you were going?"

I chuckled. "Guess it slipped my mind, the same way I forgot to tell you." In the distance, I heard the wallah call again. "Besides, there's no way that one would know where to find me. It's probably a different one."

I called once more for good luck, then went back to fixing dinner.

The next day I was alone. Gilda had lab work to do. I hadn't bothered to pack more than a token lunch, and no dinner at all, as we'd made plans to eat together that evening at camp.

As soon as my feet touched the ground, I heard a loud *Wall-ah!* from right over my head. I craned my neck, scanning the silhouettes of the trees against the early morning sky, and sure enough, there was a wallah peering down at me.

"Wall-ah," I called softly, then went about my business.

A low, snuffling grunt came from somewhere off on the other side of the skitter. I peered into the gloom, barely able to make out a large body ambling through the trees. It didn't act threatening, so I busied myself unloading gear from the back of the skitter.

Whiff-crash! A small sapling whipped down to the ground as though felled by an ax. I made a standing jump from the ground, clear over the side of the skitter, into the cargo bay. Adrenaline reached flood stage in my bloodstream in less time than it takes to gasp. I stared out at the beast just as its head snapped around towards me. I had a curious momentary feeling of vulnerability, as though this amiable looking creature was about to . . . .

And it bolted straight for me.

When it reached the wing of the skitter, it barely paused. It jumped up on top. But the smoothness of the aluminum skin caught it by surprise, and its paws slipped. It went down in an ungainly heap and slid off the rear edge of the wing, to land on the ground with an undignified *whump!*

What I gained in seconds, I lost in attitude. Now the beast was *mad.* It clambered back up on the wing, claws extended—ripping gouges in the sheet metal.

My gun was in the copilot's seat, leaning against the back, just out of reach. A move for the gun would bring me within reach of the thing's claws.

Something made me glance up at the wallah. Its eyes were riveted on mine. *Save me,* it seemed to be saying.

What the wallah had to worry about, I didn't know. It was safe up in the tree. I was the one who was face to face with an animal whose claws could puncture aluminum. But, pet or

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not, there was something about that look that I could not deny.

My eyes dropped to the beast, now testing the edge of the cargo bay with a forepaw before committing its weight. I gauged the distance to the seat, then crouched and sprang just as the creature heaved itself in. My feet grazed its snout as I went over, throwing me off balance. I slammed face first into the dash, then fell into the floorboard, feet sticking up into the air over the back of the seat.

Stunned, I could hardly see. Blood dripped from my face onto the floorboard of the skitter. Twisting from the hips, I reached back and upwards for the gun just as a vise closed on my left foot and started trying to wrench it off. I lined up the barrel of the gun with the beady eyes, then froze. The laser bolt would slice neatly through the skull and possibly my foot as well if my aim wasn't perfect. I jerked on my foot, trying to get it back.

Wrong move.

The animal growled deep in its throat and clamped down harder, claiming its prize. Pain lanced up my leg. It started backing up, dragging me with it, over the seat back, into the cargo bay where I'd be easier to gnaw on. I managed to hang onto the gun as I went up and over, but nearly lost it when I dropped onto the flat metal floor.

Even prepared for it, I lost my breath. I was dimly aware that the pressure on my foot had eased, but I couldn't see the beast—my vision refused to clear.

I needn't have worried about trying to locate the damned animal. Two full sets of silverware fastened onto my shin. Steak knives, dinner knives, forks, the works. He was busily trying to make the opposing sets meet in the middle. Dignity be damned—I screamed.

I brought the gun around to aim roughly where the animal should be, over somewhere to my right, fumbled for the trigger, and fired. Nothing happened. I shook my head to clear my eyes. I'd fired in the wrong direction entirely. There was a large dark blur off to my left. I aimed the muzzle at the middle of the mass and fired.

The beast howled. I fired again and it let go of my leg. I fired again just as it swatted the barrel, but as the gun left my hand, the beam swept upwards in an arc, from the thing's gut through the upper part of its back—where its spine would be if it were an Earthly vertebrate.

Its back legs spasmed and it fell back on its haunches. It looked in confusion at its rear, as though willing it to work. Then it looked up, and, I swear, made eye contact with me. There seemed to me to be some fleeting instant of intimate contact—the vanquished acknowledging the victor. Then it collapsed heavily, rolling over onto its side, its panting breath hot on my ankle.

Ever so slowly, I pulled my leg away from the thing's snout. It made no move to stop me. The gun had gone over the side of the skitter and I didn't think my leg would support my weight if I went after it. I finally pulled myself into a sitting position, reached over the back of the seat, and retrieved my radio

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"This is Heath," I gasped. "Anybody there?"

I was just about to call again when Susan answered. "What do you want, Heath?"

"I need someone to come get me."

"What's wrong, lover-boy? Get lonely?"

I made a mental note to kill her if I lived long enough. "Susan, I've been attacked. I'm hurt. Send someone out here."

"What?"

"I've been bitten by something the size of a bear. My left leg is chewed up."

"Are you under attack now?"

I had to stop to catch my breath, "It's . . . here next to me. It's still breathing."

"*Next* to you? Get away from it, you idiot!"

"Susan, I can't move."

"Then shoot it!"

"I can't get to the gun."

"Then how did you—"

I snapped. "Goddammit, Susan, are you going to sit there and argue with me, or are you going to get someone out here?"

"I'll find someone. Stand by."

I collapsed back against the seat. Idly, I noted that the pool of blood under my leg was getting larger. Have to do something about that. I made a mental note to get around to doing so real soon, but just at the moment I was tired and had to rest.

That damned bear-thing was mauling my leg again. I could feel it. And it hurt like hell.

I could hear voices. Human voices. Gilda's voice. I had to tell Gilda to stay back. Dangerous animal here.

Cranking my eyelids open took more strength than I had expected. I'd need a full night's sleep just to recover.

It wasn't the animal chewing on my leg, it was Nathan Chandler, our doctor. Given a choice between him and the creature, I'd be hard pressed to say which one was worse. Nathan was cutting my pants leg away just above my knee. When he slit the fabric lengthwise, exposing the lower half of my leg, I heard a sharp intake of breath next to my right ear.

I turned my head. It was Gilda, staring in horror at the fresh hamburger. I managed to locate my voice. "Gilda? What are you doing here?"

She looked at me. "You called in. Then you didn't answer your radio. Did you think I'd sit at camp and wait?"

"There's a . . . a thing. Like a bear. It's—"

"It's dead. It's on the ground so Nathan would have room to work."

Adam Anderson's head popped up over the side of the skitter. "It's possible these things are telepathic," he said conversationally.

"Telepathic? What makes you think—"

"Tony saw one of these things yesterday. A blueheart walked right up to it and got eaten. Tony thought it sufficiently strange that he kept the critter in sight for the rest of the day."

I gave him a skeptical grunt. "Maybe it uses scent as a lure. Maybe it makes some kind of subsonic call. Hell, it probably—"

He eyed me. "Then it tried to eat Tony. It turned and walked right past

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him. As soon as he figured out that it might be looking for him, he got scared. *Bingo!*" He clapped his hands together sharply. "The critter turned and looked straight at him. He said that it was an almost out-of-body experience. He could see himself through the creature's eyes, almost as though he was outlined in neon. That's in spite of the fact that he was hidden behind heavy brush."

"It could see him through brush?" I asked.

Anderson nodded. "Clear as day. It was his fear that it was reading. Until then he was invisible."

Nathan was tying off my leg with gauze. He gave a particularly vicious jerk that made my head swim. "But this thing evolved here. How the hell could it read our minds if we came from an entirely different evolutionary environment?"

Anderson shrugged. "Maybe fear is universal."

That gave me something to digest. Whether I liked it or not, it did match my experience. "I've got just one more question."

Anderson looked up from where Nathan was finishing with my leg. "And what's that?"

"How many more of these things are there?" Maybe I didn't want to be a colonist here, after all.

Nathan checked my other leg, but it was only bruised. Likewise, my boots had protected my feet from serious damage. He then attended to the cut on my forehead. He cleaned and bandaged it, then pronounced me good as new.

"If this is the condition I was in when I was new, I'd rather be used again, if you don't mind," I told him.

"Well," he allowed, "barring some minor discomfort."

"Minor," I said to Gilda. I gestured at my leg. "He calls this minor. Notice that he didn't offer to trade legs with me while mine heals."

"I'll get out a crutch for you when we get back to camp," he offered.

I thanked him, then struggled to my feet, distributing my weight between my better leg and Gilda's shoulder. "I want to take another look at this critter. If it's telepathic, then we're going to need a better idea of what we're up against."

I peg-legged my way to the rear corner of the cargo bin and sat heavily on the edge, looking down at my fallen adversary. Anderson and Mia Sands were crouched on the ground next to it. They were prodding its head like phrenologists.

"So what's the verdict?" I asked.

"Looking for soft spots," Mia said.

"I assure you it didn't have a noticeable soft spot for me."

She had the grace to chuckle. "We were curious as to whether the skull was continuous or whether there was soft tissue. Telepaths might have made some interesting cranial adaptations."

Anderson looked up. "We'll be taking your friend back to camp to dissect. Tony was foolish enough to let his get away."

"Oh, I meant to ask . . . how did Tony keep from getting eaten?"

"He climbed a tree."

I looked up, expecting to see the wallah, but it was nowhere to be found. But the rump of the animal I'd

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killed had been chewed. The wallah had eaten breakfast before leaving. I felt lucky. It could just as easily have been me.

Obviously, having my leg out of commission was a nuisance, but the corollary was that I got to see more of Gilda. Clouds with silver linings, and all that.

I spent the day catching up on busy work, mostly writing reports, then stumped ungracefully over to eat supper—for some reason, walking on crutches was not coming easily to me. I put my tray on the table, leaned my crutches against the edge and slumped into a seat. It wasn't long before Gilda showed up.

"Say, fella, is that an empty spot next to you?" she asked, head cocked.

"Sit. I need someone to complain to—doctor's orders. Supposed to speed the healing process if I act pitiful."

She gave me a skeptical look, but slid in. "I spent the morning doing lab work, and the afternoon on a stint at the radio."

I shook my head. "I understand that we're short-handed and all that, but it seems rather haphazard to have to depend on you and Susan to handle the radio while you're not doing lab work. As long as we have people out in the field, we ought—"

"So, how's the leg?" Mike Gaston boomed from right behind me.

I twisted around to look up at him. "Nathan has me on accelerators, so it should be better by the end of the week."

He inspected Gilda as though he expected to find my fingerprints on his property. He nodded to her. "Hello."

She gave him a polite smile, but said nothing in return.

He looked back at me, gesturing at my leg. "You wouldn't be in this situation if it weren't for your little buddy."

I frowned, not sure what he meant. "What little buddy?"

"Your wallah."

I shrugged. "I couldn't just let that thing eat the wallah."

"The wallah was safe."

I had the uncomfortable feeling that Mike and I were having separate conversations on diverging paths. "Maybe it could climb."

"Fast enough to catch a wallah? I doubt it. All the wallah had to do was bounce over to the next tree to get away. Besides, the thing's foot structure was wrong for a climber."

"I was a little too busy to notice," I replied testily. "I was more interested in its teeth."

He snorted. "Just be more careful the next time a wallah wants you to shoot something." Then he left, leaving me wondering exactly what the hell he'd been getting at.

After sitting around for a few days, the inactivity was getting to me. I'd done enough paperwork to keep a small army of bureaucrats busy for a month, and was beginning to annoy even myself. I hadn't realized how much I valued my time out in the field until it was taken away from me. So when Adam dropped by my hut to say that they were organizing a picnic, I jumped at the chance to come along. Figuratively speaking, of course.

Six hours later, I was sitting

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propped against the bole of a tree, my belly full and the late afternoon sunshine warm on my face. Off to one side, I heard a small noise, then a muted *wall-ah*. I looked up and, sure enough, there was a wallah on a branch looking down at me.

Gilda looked up at him and said, "Your pet's come to check on you."

"It's probably not mine."

She shrugged. "Might be. It sure is looking at you hard. Do you think it wants something?"

"Dinner probably. Remember that old thing about not feeding stray cats unless you want a pet? This guy never shows up unless it's dinnertime."

She gestured at the remains of our picnic. "Will he eat leftovers?"

"I don't think so. I tried it a couple of times over at Bareback. He wouldn't come near the stuff. I guess he likes his meat fresh."

About that time I saw a Wilson's squirrel-cat just inside the edge of the trees on the opposite side of the clearing, headed more or less our way. I made a long reach and snagged my rifle by the stock where it lay on the ground near me. Pulling it to me, I lifted, aimed . . .

And died.

Hot pain lanced through my body, seemingly into the tree trunk behind me. My vision swam. I saw double: I saw the barrel of my rifle, yet superimposed over it, I saw the ground coming up. The ground hit me, even as I sat still with my back against the tree. Then the double vision faded, and all I could see was my rifle barrel drooping. I could hear myself gasping for breath.

"Heath? Heath, are you all right?" Gilda cried.

I could hardly breathe. "God, that hurt," I whispered hoarsely.

"What happened?" she asked.

"My—"

"His wallah had him," came Mike Gaston's voice. "It was controlling him—using him to get something to eat."

"Mike, stop it. Something happened, and—"

"What happened was that the wallah was hungry. They're telepathic, just like the animal that bit his leg. The wallah was telling him to shoot it some dinner."

"That's ridiculous!"

"I shot the wallah. When it died, it released Heath."

"But—"

"Wallahs aren't like anything on Earth. They're a new type of animal, halfway between a predator and a scavenger. They eat freshly killed meat, but they can't do the killing themselves—they're too small, too weak. So they've adapted to use larger, stronger animals to bring down their prey for them. It's a symbiosis. The animal which does the killing benefits because the wallah brings the prey right to them. Then the wallah gets the leftovers. Since they're small, they don't need much, so the predator that kills the animal gets to eat its fill. The wallah simply orchestrates the kill. And Heath here was the best thing it had ever seen. Fresh meat daily. No wonder the wallah tracked after him so faithfully."

"So you killed it? Why? To prove a point?"

Mike shrugged, unconcerned. "It's just a wallah."

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"It was *his* wallah."

He shook his head. "No . . . he was its human."

I gently floated the skitter down onto the crest of Bareback Ridge. It was early morning and the sun was still struggling to clear the horizon. For a long time, I just sat, watching the morning come.

I had brought the wallah with me, wrapped in an old rag. I felt that the least I could do was bring him home to bury him. Not that anyone would know or care, but I felt I owed the poor thing that much.

After a bit I climbed out, went around to the other side of the skitter and got the shovel and the wallah. Stepping carefully—my legs were still none too steady—I made my way down the slope to the place where I'd first seen him.

Digging a hole was harder than I'd anticipated. The pain from my leg slowed me down. After a bit, I had an uneven oval large enough to hold the small body. I knelt down and placed the limp bundle in the ground then began to shovel the dirt back in.

"Aren't you going to say something?"

I looked up to find Gilda watching from a few feet away. Back up the hill, there was another skitter next to mine.

I shrugged. "There's nothing much to say, I guess. I just thought I'd lay the little guy to rest."

She stepped closer and used the cuff of her sleeve to dab at my eyes. "I'd never realized you were such a sentimental fellow."

"I'm not, really. Those are just dewdrops."

"Oh." She nodded. "I see."

I looked down at the wallah. "I'll be done here in a minute."

"Take your time. I just got worried when I saw that you'd left early and alone."

"I didn't think you'd want to come."

She smiled gently. "If it's important to you, then it's important to me."

"I just. . . ." I began, then stopped, unsure how to express myself.

She cut right to the heart of the matter. "You're angry with Mike, aren't you? There's more to this than just him killing your pet wallah."

It took me a moment to formulate my thoughts. "He humiliated me, publicly. He proved to all and sundry that I was under the control of an animal not much larger than a cat. I imagine that he thought it was great fun watching me twitch while the wallah was dying."

She sighed. "Mike only did it because he was jealous. If he wanted to show me how smart and in control he was, it backfired. What he did was cowardly, low, and cruel. I don't think there's any more convincing way that he could have shown just how shallow he is."

That meant . . . what? I still wasn't sure where I stood with her. Was there even a chance? "Does that mean you and he—"

She snorted. "No more Mike Gaston for me. Count on it. I'm yours, if you'll have me."

My smile was slow to build. "Have you ever given any thought to settling down?" ■

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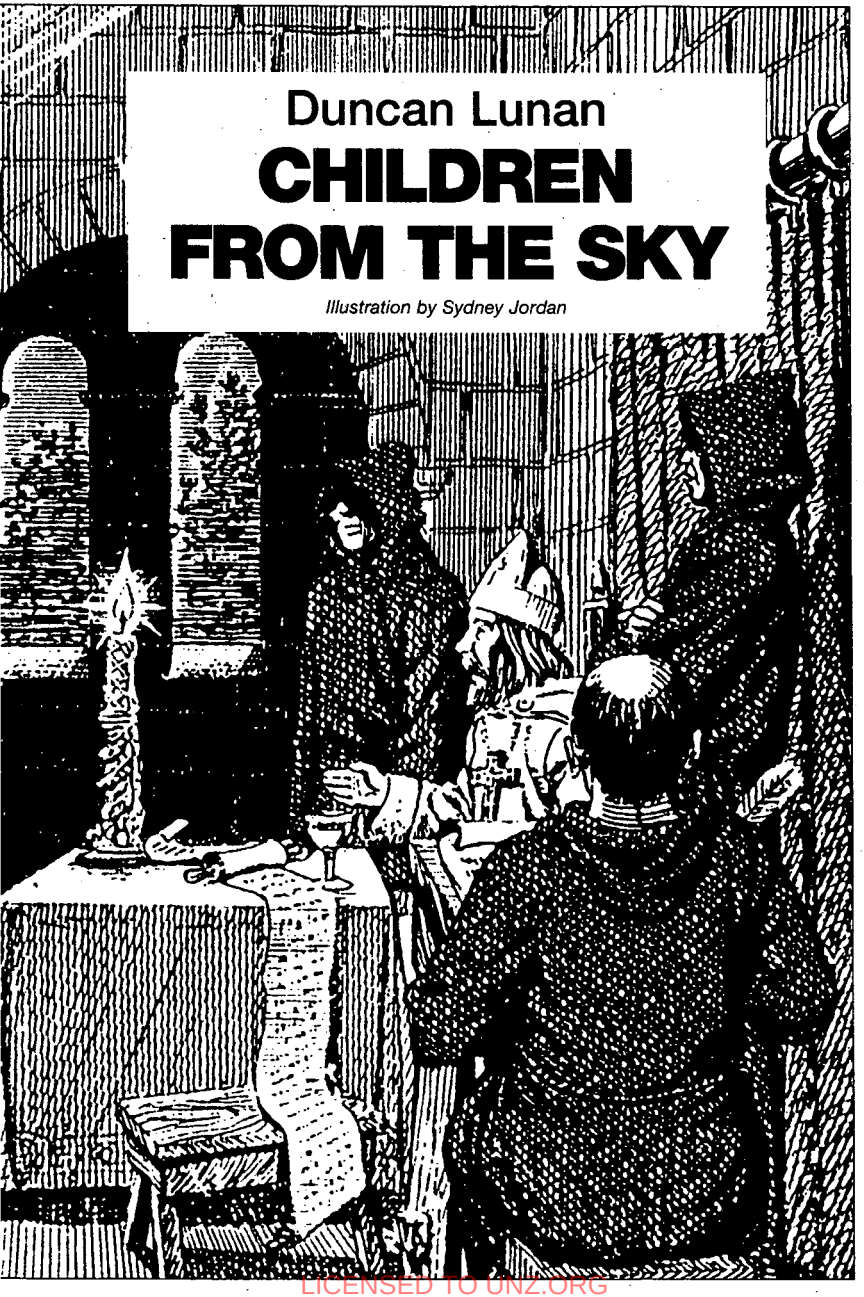
Duncan Lunan

CHILDREN FROM THE SKY

Illustration by Sydney Jordan



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In "The Anatomy of Melancholy" by Robert Burton (1651), Part 2 Mem. 3, "A Digression of the Air," includes all he knows about astronomy.[1] Copernicus, Kepler, and Galileo had proved the planets were actual worlds, moving in ellipses, not solid crystal shells, so space travel might be possible—"to take wings and fly up . . . command the spheres and heavens, and see what is done amongst them." And if we can go to them. . . .

"Then (I say) the Earth, [Mars, and Venus] be planets alike, inhabited alike, moved about [the Sun] alike, and it may be that those two green children which Nubrigensis speaks of in his time, that fell from heaven, came from thence. . . ."

Various writers have picked up that story, but none have seen what Burton recognized: if the children's story was true then their homeland could not be on Earth.

Canon William of Newburgh (Nubrigensis) wrote his "Historia Rerum Anglicarum" (History of English Affairs) in 1195-98. He was sceptical about wonderful events, and he was uneasy about this one, because miracles are supposed to be instructional, but he could draw no religious or moral lesson from it. Unlike others of the time, it has no roots in folk-tales; attributing those to "wicked angels," he adds, "However of those green children, who are said to have emerged from the earth, the explanation is so much more obscure, that the frailty of our perception is not adequate to unearth it." He's thought never to have left Yorkshire, yet this time he interviewed so many witnesses, witnesses of such quality that they convinced him—implying that he'd been to the scene, in Suffolk.[2]

Exact wording is important, even if it reads awkwardly in English. It's William's Book One, Chapter 27, *De Viridibus Pueris*—concerning the green children. During the reign of King Stephen, he says, at an earthwork near Woolpit village in Suffolk, (East Anglia), seven miles east of Bury St. Edmunds, at harvest time, "there emerged two children, a male and a female, green of the entire body and dressed in clothing of extraordinary color and unknown material." They were given no food at first, but even near death they wouldn't consider any food which was offered. They were saved eventually by bean plants, which happened to be just the same color they were; but even then, they looked first for nourishment in the stalks, "and finding nothing in the hollow of the stalks, they wept bitterly. Then one of those present held out to them the beans removed from the pods, which at once they accepted and ate up freely." After that, they were weaned on to bread and by degrees to a full normal diet: their green color faded and they became normal themselves.

Ralph, sixth abbot of Coggeshall monastery in Essex, 25 miles south of Woolpit, tells the same story in his "Chronicon Anglicanum," *De quodam puero et puella de terra emergentibus*, of a certain boy and girl emerging from the earth. There's no copying; the few words they share seem significant—and Ralph got the story from the family with whom the formerly green girl was living as an

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adult. In his version, the children reached Woolpit by wandering through a network of caves.[3] From now on I'll use (WN) to identify William's text and (RC) for Ralph's.

"No one was able to understand their speech. Therefore taken to the home, at Wikes, of Sir Richard de Calna, a sort of knight, to be wondered at, they wept inconsolably. Bread and other common foods were offered to them, but they did not wish to be nourished by any food which was brought to them, so for a long time they were tormented by great hunger, because they believed all the food of that place to be inedible, as the girl later admitted. . . ." (RC)

Most writers treat this as a children's story, making the children runaways from somewhere. There is a condition called "chlorosis," an iron deficiency which turns people green (particularly young adolescent girls), rarely found in Europe after 1910; so it's often suggested that the children were raised on a poor diet, or wandering, eating only berries, after being lost from some primitive underground community. But there's nowhere for such a tribe in walking distance: that part of Suffolk is low-lying, with the water table very near the surface, and Ralph's caves simply don't exist.

It's also suggested that the Woolpit people couldn't understand the dialect from even a few villages off. However, Woolpit wasn't isolated: it was a market-town, at a triple junction with the main trading and pilgrim route to Bury St. Edmunds via Ipswich. The villagers would recognize many dialects and most European languages; they would know the sound of Latin and Greek from church services, and of Hebrew from the Jewish community in town. And if the children were from only a few villages off, it's incredible that even after days of starvation, they would refuse good, normal food.

So Where Were They From?

They didn't recognize the bean plants—they didn't even know which part was edible, but the color was crucial. There's an elision in what the girl says below: not *every* living thing in her homeland is that color, just everything that's safe to eat. It's not a deficiency but an additive, a color code so simple that even children know it.

And what she said about that homeland was clearly what impressed Burton:

"Naturally when now they had our habit of speaking, they were asked who and from whence they were, they are said to have replied: 'People of the land of Saint Martin, who of course in the land of our birth is held in the very highest exceptional respect.' . . . Asked whether the Sun rose [in that place], 'But the sun,' they said, 'of our countries does not rise; and our country is little lit by its rays, but is satisfied with that measure of light, which with you precedes sunrise or follows sunset. Moreover a certain bright land is seen not far from our land, with a very broad river dividing the two.' These and many other things, *which it would be tedious to retell,* [my italics!] they are said to have replied to those struck inquisitively." (WN)

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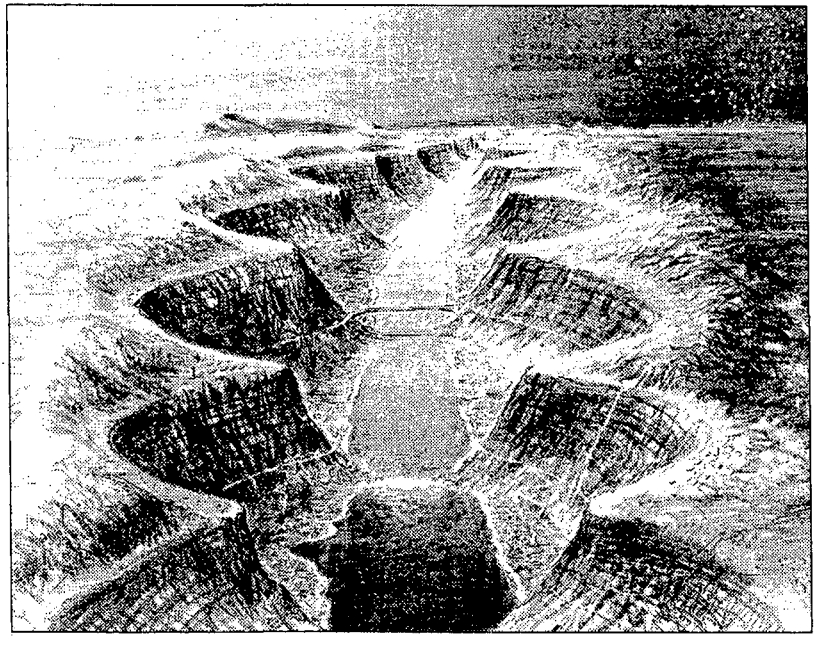
"Truly asked often about the people of her country, she asserted that they saw no sun, but were pleased with a certain light, as if happened after sunset. . . . When they emerged from the pit, as if astonished and made breathless with fear by the excessive brightness of the sun and the unaccustomed temperature of the air, they stayed for a long time over the rim of the cavern. . . ." (RC)

It sounds like an Earth-like world, with a trapped rotation, keeping one face to its sun as the Moon does to us.[4] We used to think that Mercury's rotation was trapped, and that it might allow life to exist in the "twilight zone"—the origin of the expression. But Burton knew from the astronomy of the Renaissance that such conditions couldn't be found on Earth.

The "very broad river" round the terminator could be part of the temperature control system. Without planetary engineering, an Earth-like world with a trapped rotation would become uninhabitable: oceans would boil, triggering a runaway greenhouse effect before the atmosphere froze out on the dark side.[5] The details William found tedious might include mountain barriers between twilight zone and dark: glaciers there would feed the river, graded to run back towards the equator.

To maintain a breathable atmosphere the twilight zone must be intensively cultivated, forested, or mostly shallow sea. However, if the



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atmosphere could be contained there, that would greatly reduce the volumes of oxygen and nitrogen required. . . .

July 1994 saw the multiple impacts of Comet Shoemaker-Levy with Jupiter. The stress of a previous flyby had split the comet into 22 pieces, which hit the planet the next time. It renewed interest in the overlapping crater chains on Ganymede and Callisto, the two of Jupiter's large moons which preserve the record of bombardment during their history. The longest of the chains spans 620 kilometers, with 25 craters of about 25 kilometers in diameter, formed by bodies less than 4 kilometers across.[6] On Earth, the impacting asteroid that killed the dinosaurs was about 16 kilometers across and its crater ten times that size. Chains of those could form a deep groove on the planet's surface, as on a much smaller scale with Phobos, the inner moon of Mars. A 100-mile wide trench round an Earth-sized planet from pole to pole would take 250 such objects, reasonable for a typical planetary system.

A cometary body 80 kilometers across could provide a breathable atmosphere for our Moon, which has 1/16 the surface area of the Earth;[7] that corresponds to 8,000 Shoemaker-Levy-type fragments from 400 large cometary nuclei. As the valley's area is only 1/80 of the Earth's, 2,500 such impacts would give it an Earth-like atmosphere (after processing by algae and higher plants) with a channel as wide as the Mississippi along the center. But to terraform just one hemisphere's twilight zone half as many asteroids and comets would be needed; and that might be all, because on the Moon, Mars, and Mercury there's "chaotic terrain" opposite the big impact basins—broken up by the shockwaves from the far side of the planet. Perhaps a habitable valley doesn't even need to run from pole to pole? I've had fun designing this world, with friends, but I'll have to let Syd Jordan's pictures tell the story.

The children were human: no abnormalities, adapted to terrestrial food, lost their previous coloring, the girl apparently married. If they weren't from the future, their home settlement was built by another species who transplanted terrestrial life to the new world. "Truly asked often about the people of her country, she asserted that as many as all the inhabitants and all plants that were held in that land/world were dyed with the color green." (RC) If plants there were genetically modified to distinguish terrestrial life from what's inedible, humans could be dyed by it: vegetable dyes here turn people purple or orange. Ralph says the girl believed food here to be *incomestibilia,* "things not to be consumed for nourishment"—not "poisonous." It suggests other life-forms which the human system can't absorb—perhaps because of different proteins, different amino acids, or a left-hand/right-hand molecular bias opposite to ours.[8] It would be a long-term experiment in compatibility of different life-forms—perhaps intended to be one-way, to prevent contamination of Earth, but on-site, biospheres without walls.

William's account and Ralph's both use the causative word *quia,* "because." The children came here *be-*

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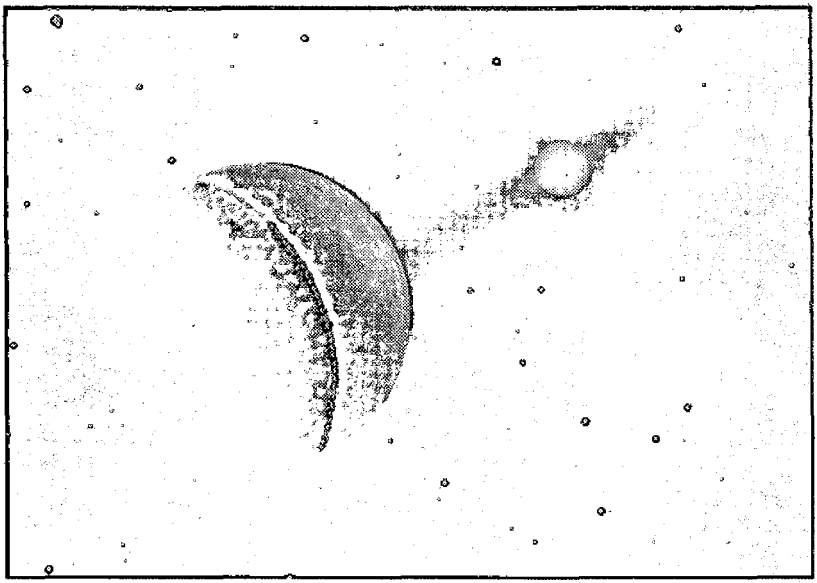

cause they were out with their father's animals on a particular day, as if they shouldn't have been. William's word *pascere,* to pasture, can mean to enlarge a flock or herd. Were the children caught in a backlash of a livestock transfer from Earth to the colony?

"We heard a great sound, as now we're accustomed to hear at Saint Edmund's *cum signa concrepare dicuntur,*" after which they found themselves at Woolpit, "suddenly, as if placed in some absence of mind" (WN). "Signa concrepare" was a medieval Latin metaphor for ringing bells, but it means "flags waving violently," which could describe the "whirling draperies" effect of an auroral display. And that may suggest the children understood what happened to them.

When the radiation belts trapped in the Earth's magnetosphere are overloaded by sub-atomic particles from the Sun, aurora storms occur where the magnetic field lines enter the upper atmosphere. Power-lines and communications can be badly affected. But aurorae can't happen on a world with a trapped rotation. Coriolis forces would be almost ineffective within it, whereas currents within the core generate Earth's magnetic field. So the children's planet won't have one.

And the second half of the 12th century saw the most violent solar activity since the Bronze Age—shown by tree-ring records, naked-eye sightings of sunspots, and vivid aurorae farther south than usual, in the Far East as well as Europe (Fig.4).[9] On Christmas night, 1172, during an aurora display, a clap of thunder "sudden and terrible" was heard throughout England, Ireland, and France, like a sonic boom, or an airburst like the Tunguska mete-

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orite of 1908.[10] In February 1173, again during an auroral display, a mass of fire passed over Derry in Northern Ireland, moving southeast, and was "as bright as the rising midsummer Sun" on the northern horizon at Canterbury.[11] Auroral storms continued for 25 years, but 1173 is crucial. It's sometimes easier to understand high technology by what can go wrong with it, and these incidents helped my friend Andrew Paterson to see what may have been happening.

The matter-transmitter would be a combination of the "quantum scanning" and "wormhole" systems, which John Cramer and others have described in *Analog*.[12] Surface gravity on the two worlds linked would have to be very similar—but when they arrived here, the children were able to run. Normally it would need locating devices, generating matched electrical fields at the two locations—which momentarily become one, when the fields merge. But gateways to other worlds could be opened initially, at random, by setting a charge which could be matched by lightning and other natural effects on an Earth-like world. So in the unexpectedly intense magnetic storms of the late 12th century, stray electric fields on Earth could cause matter-transmitter accidents. Or does the transmitter disturb the magnetic fields of Earth and Sun—in which case, what was happening in the Bronze Age? See below.

So Did it Really Happen?

In 1993 I visited Woolpit, to get some local background for this article. I didn't expect more, but I was pitchforked into eighteen months of research which generated a full-length book. It seems nobody else has done it, because the facts weren't hard to find, except for the work involved: there's no sign of a cover-up, not since the 12th century at any rate.

Woolpit is now just south of the A45 to Ipswich. The village was given by the Earl of the East Angles to Bury St. Edmunds Abbey between 1005 and 1009. The last wolves in East Anglia were caught there, and the village sign, for the royal Jubilee in 1977, shows the green children and the wolves. There's no record of the pit as such. But northeast of the church is the Lady's Well, supposed to have curative powers for eyesight, and there were health pilgrimages to Woolpit for centuries. The moats leading from it have only recently been restored, which may explain why it's not been connected with the green children; but on the two sides away from the well they are deep and wide enough to hide their arrival.

"The home of Sir Richard de Calna, at Wikes," took more finding, but his family held Cane in Wiltshire: Nigel de Calna was physician to William the Conqueror and chaplain to Henry I.[13] Richard was a younger son of the family, nephew of Adam de Calna and brother of Roger, both archdeacons of Norwich.[14] Two brothers stayed in Wiltshire, but Richard followed Adam and Roger to East Anglia. By 1135 he held land at Knettishall and Wykes, eight miles NNW of Woolpit, and in 1156 he was excused all rents be-

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cause of major, undisclosed service to the king. He died in 1189, leaving Wykes to his heirs, and his granddaughter Sibylla sold it in 1235.[15] The hall was demolished in the 18th century, but an old tithe map shows formal gardens; the farmer there has found wooden posts from some old, large building, probably where the children were taken.

Given that they came from the ground, didn't speak English and were green, the children were quite well treated (though it was quickly learned that they were green all over). Nevertheless, nobody thought to feed them for days—probably more, given the effects of their fasting. But why take them NNW to Wykes, instead of west to the Abbey, to which Woolpit belonged?

Between 1160 and 1182 Woolpit was *not* controlled by Bury St. Edmunds—see below. In 1160-61 and 1173-74, there was no priest there to take charge of the children, or make the villagers take them to the Abbey. The year 1161 would put the girl in her late 30's during de Calna's visits to Coggeshall, and that's very old for Ralph's account. Ralph died in 1228 or 1230, so even if he was then 70, he was born around 1160. He was a canon at Barnwell in Cambridge, and came to Coggeshall after 1176, probably around 1180. Since Richard de Calna died about 1189, his visits to Ralph when the girl was an adult must have been in the 1180s. She had to be at least ten when she arrived, to conduct herself so well at the trial (see below), so if she'd arrived in 1173, she would be 26 at de Calna's death.

Sir Richard may have been a Knight Templar. Both the Order's preceptories in Suffolk were in his area, and the Templar Master in England had a knight in service to him in the village next door, with a sub-tenant at Wykes itself.[16] They had a big complex at Cressing Temple, near Coggeshall,[17] and Sir Richard may have been a physician to all of them. De Calna couldn't have been a full Templar, but there were two associated categories: *frères mariés,* married knights, and *fratres ad terminum* who joined for a time, e.g. a crusade or pilgrimage. Either fits Ralph's description of him as "a sort of knight."

In 1155, Henry II seized the castles and lands of William Peverell, baron of Nottingham and Derby. There had been an odd episode in Peverell's time: a swineherd who entered the Devil's Cavern, below his Peak Castle, came out in a flat, cultivated, well-lit country, at harvest time, where the people spoke his language; where the lord of the country told him to collect his lost pig and go home by the same route, so he did.[3]

Henry's chronicler thought the swineherd had been to the other side of the world, but East Anglia fits the description. The report reached him through a Prior of Kenilworth who took office in 1160. And that year, Henry annexed Woolpit. (De Calna's neighbor, the English Master of the Templars, was with him in France when he did it.)[18] A future abbot went to Rome to get the move reversed, and was banished twice to the Holy Land for interfering: Henry refused two direct orders from the Pope

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to give Woolpit back.[19] The books say he assigned Woolpit to one of his poor clerks, but first it was Geoffrey Ridell, archdeacon of Canterbury and acting vice-chancellor of England; then Walter de Coutances, the deputy vice-chancellor. If people of this caliber were looking after a village of just 60 people, annual revenue 10 pounds per year, something big was going on. And it gets bigger.

The War and the Trial.

In 1164 Henry seized Hagenet Castle, four miles from Woolpit. In 1173, he faced rebellion by three of his sons, fomented by his queen Eleanor of Aquitaine, and backed by the kings of France and Scotland. In late July, 1173, Henry rushed back from the war in France for four days, going not to London or to any rebel area but to East Anglia.[18] We might guess that he went to Wykes to see the children, or had them brought to him, because he then sent crack troops to Peak and Hagenet Castles.

In October the earl of Leicester invaded East Anglia with a Flemish army, and turned aside to take Hagenet. Instead of killing the garrison in the usual way, he kept the entire unit of 300 for ransom. The detour and hostages slowed him down, so the combined armies of England and southern Ireland cut his army to pieces near Bury St. Edmunds. It must have seemed as if the children had been sent by God to save the kingdom—especially if Henry was expecting some kind of miracle at Woolpit.

It's undeniable now that the king was deeply involved: as my friend John Braithwaite said, "If it's not ET Contact, it's the political thriller of all time."

But even when the children were on normal food, lost their green color and learned English, they weren't safe. "It appeared to the wise, that they might receive the sacrament of holy baptism, and that too [even that] was done. . . . Naturally when now they had our habit of speaking, they were asked who and from whence they were, they are said to have replied: 'People of the land of Saint Martin, who of course in the land of our birth is held in the very highest exceptional respect. . . .' Asked whether Christ was believed in, in that place, and whether the Sun rose, they said that land was Christian, and had churches. . . ." (WN)

These were not casual questions. A century later the children would have faced the Inquisition, but though they were spared that, the question at stake (literally) was whether they had souls. Like trying a suspected heretic, it required the authority of a bishop, and if he ruled against them the outcome was certain. In quoting the girl's testimony Ralph uses the verbs *asserebat,* "swore under oath" and the passive *confessa est,* "formally stated " She did all the talking, as if she'd told her kid brother to keep quiet and as if she'd been coached: showing that she wasn't a savage from some underground tribe.

The Abbots of Bury St. Edmunds and Coggeshall hadn't authority to conduct the hearing; it couldn't even have been at Coggeshall Abbey, because women were barred from Cis-

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tercian grounds and the monks couldn't administer baptism. But the Abbot's superior, Gilbert Foliot, Bishop of London, could have heard the case nearby (Fig.l), baptized the children, and had the boy buried at the Abbey. And the stress on St. Martin implicates the Bishop of London: the church of St. Martin-le-Grand, next door to St. Paul's in London, owned the one on the Templars's land at Cressing Temple. St. Martin-le-Grand was the principal sanctuary in England, and in the Domesday Book, its Essex properties are listed under the heading, in block capitals, TERRA SANCTI MARTINI—"the Land of St. Martin." By calling themselves "people of the land of St. Martin," the children were asking for the sanctuary they so badly needed.

William of Newburgh says the girl then married a man of Lynn (modern King's Lynn) and dropped out of sight. But he also said she arrived in the reign of King Stephen, before 1155 and 1173 is more likely. The Lynn story is probably a cover-up: in 1190 Lynn staged a massacre of Jews, which turned into a major riot by foreign seamen, as William himself recounts. So if William looked for an old woman and couldn't find her, he'd think she was killed in the fighting. Ralph's account of her early adult years is more interesting.

"Being later reborn by immersion of holy baptism, and remaining for many years in the service of the aforesaid knight (as we frequently heard from the same knight and his family), she showed herself greatly willful and independent. . . ." (RC)

Ralph's words *lasciva et petulans* mean literally "lascivious and wanton"; that might be the 12th-century view of a woman from a sophisticated culture, someone we would describe as liberated, but then why give her house-room for years?

When Ralph says she was in service of de Calna, most take that to mean as a domestic servant. Not at all, I found when I checked the categories of feudal service. "In ministerio praedicti militis" means *administrative* service, like government ministry or the ministry of the church. Since de Calna held two large estates, plus properties in Essex and Hertfordshire, he was making full use of her intelligence.

So why "wanton and lascivious"? If the Bishop made her Sir Richard's ward, de Calna would have to find her a husband at the age of fourteen.[20] Even if her exact age was unknown, he'd have a problem by the 1180s if he wanted to keep her. He could only be freed from the obligation to marry her off if she were unchaste, so blackening her name at Coggeshall, from where it would get back to London, might do it. She would also lose any de Calna property the king had assigned to her.

I thought I'd identified her as Sibylla de Calna, a royal ward, with a marriage to John Fitz-Bernard personally arranged by the king.[21] But Sibylla was Sir Richard's granddaughter, five years old when she was orphaned in 1185, too young to fit in with the other dates. But there was an older coheir to some minor property in 1198, named Agnes, who is never identified as a de Calna. She was married to

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Richard Barre, who was on Geoffrey Ridell's staff in the 1173 rebellion—so he could have been in charge of Woolpit when the children arrived.

Agnes and Richard had an illegitimate son, named after him, in 1177-78 when she would first have been of marriageable age. If it was an attempt to force de Calna to release her, it failed: the boy was fostered out with Barre's neighbors in Staffordshire, and it let de Calna brand her "wanton and lascivious" while still having her run his estates. Meanwhile, other things were happening.

The Search Party

Probably Bishop Foliot gave orders from Henry for the children's upbringing, but it was too late for the boy, overcome as he was by depression—a condition worsened by green beans, on which he had lived for so long. It would be good to find his body, especially if he was wearing the clothes of unknown color and material in which he arrived—but it's not likely because, after 1176 but before Ralph reached Coggeshall, a group of knights dressed and speaking as top-ranking Templars appeared inside the Abbey grounds.[3] Though seen at the Guest House and the cemetery, they jumped in, around and out again unobserved. Locally this incident is now called "the Ghost Templars," but neither Ralph nor his witnesses described them as ghosts: they were tough soldiers who might do serious harm. (Templars wouldn't be buried in the Brothers' cemetery anyway.)

Abbot Peter would undoubtedly report this intrusion to the Bishop of London. It would convince Henry II that there were people with great powers within his realm—and perhaps that he should put pressure on the Templars, to gain control or access. If he did, the consequences apparently were dramatic.

On June 18th, 1178, according to the chronicler Gervase of Canterbury, "there appeared a wonderful sign, five or more men witnessing it . . ." apparently the flare from an impact on the Farside of the Moon, forming the crater Giordano Bruno.[22] But the Latin text goes on to further details, which would not have made sense until the recent Comet Shoemaker-Levy event. "It repeated this change, and more than it, *twelve times*—[my emphasis]—namely the various torments of fire, as if it endured again what had already happened, and returned to its former state. And after these and such changes, it was made as if darkened from one horn all the way to the other."[11]

If that was a natural event, it's an astonishing coincidence after the children's arrival, probably the year Agnes had a son. But if the extraterrestrials could stage such events at will, were the lunar impacts their response to pressure from Henry II, on their people on Earth? They could have treated him to a close-up view, and showed him what would happen if they put a row of such impacts through his lands in England and France. He was in Normandy at the time, but within two weeks, he and the king of France made a sudden and unexpected pilgrimage to the shrine of Thomas à Becket, and for Henry it was an annual event from then on. If

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he was pressuring the English Master of the Templars, perhaps even threatening Agnes and her newborn son, he had been frightened off. Next year there was a lunar eclipse while he was on the road, which would have underlined the previous message. And that year, while he was celebrating Christmas at Winchester, there was a mysterious underground explosion in Durham.

After that, it all went quiet. I might have suggested it was over, but in 1236 I've found two more incidents, again involving the Templars, which suggest the operation was continuing.[23] So what was Agnes doing, meantime?

She was married to Richard Barre by 1180. In 1187 he was abroad on major embassies for Henry II, returned to East Anglia in 1190, and settled in Staffordshire. De Calna's heirs rented out Wykes soon afterwards—his three grandsons were respectively a knight, a clerk, and a priest, so perhaps they couldn't manage if they'd become dependent on Agnes to run things for them. Richard Barre was now a roving justiciary, holding courts all over England. He and Agnes had a son called William, whose wife was Christiana; his first, namesake son didn't contact Agnes until the 1220s, after Barre's death in 1209, and William Barre's, and not long before his own. She outlived her husband and her legitimate and bastard sons, but was supported by Christiana and grandchildren named Richard and Maud, until the 1230s at least.

Meanwhile, back in Suffolk, Sibylla and her husband John reclaimed Wykes by force in 1224. John Fitz-Bernard died in 1229, and Sibylla and her son sold Wykes and Knettishall to Hugh de Shardilow in 1235. Things started happening again just after that, in 1236, with events involving Templars in Yorkshire and in Ireland, whereupon de Shardilow was apparently posted missing. I'm still trying to find out whether he was a Templar, and what became of him.

After 1236, it's more than a century before anything else fits the pattern; but there were big events in 1361 and 1366, and lesser ones in 1402, which might be part of it. In my book, I'm going to advance some controversial ideas as to that pattern, e.g. that the peaks of solar activity in the bronze age correspond to the creation of the colony valley, and the rising activity through the 12th century marks its settlement.

Or perhaps the conspiracy didn't involve Contact at all. I've already quoted John Braithwaite's "political thriller" comment; he also said, "If someone invents a story like this, they tend to make it out of whole cloth—it won't stand up to this kind of detailed investigation." He's involved with other friends of mine who are trying to find an alternative explanation for the whole thing. We won't be staging any theatrical quarrels: the alternative project has full access to my research, and I look forward to the outcome. Whatever happens, though, I can't better the last words of William of Newburgh, at the end of his Chapter 27:

"Let each one say what he wishes,

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and account for these things as best he can; but it does not grieve me to have set forth this strange and wonderful event."

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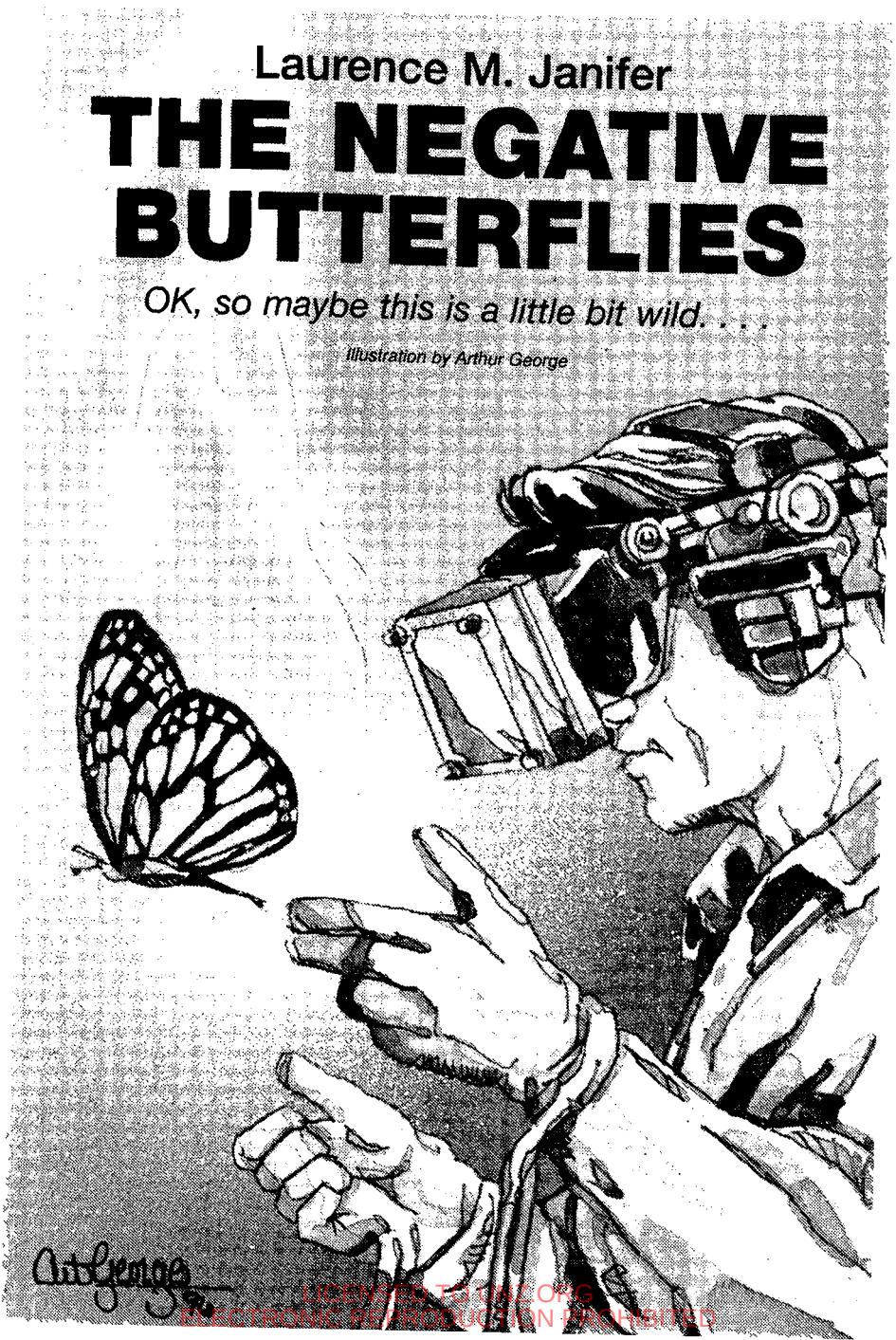
Laurence M. Janifer

THE NEGATIVE BUTTERFLIES

OK, so maybe this is a little bit wild. . . .

Illustration by Arthur George



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Dear Stan:

They do say that you never hear the one that gets you—and I believed that, just like everybody else, until I heard the one that got me. You may be wondering where in hell I have been, this last year or so, and I have been in several hells and am still clambering out of the last few; it all started at John Gotti's party.

You must know about this party, even if you live in Connecticut: Gotti, a big-time Mafia person (and I can avoid that weasel, "alleged," since he has been well and almost truly convicted) throws a gigantic Fourth of July party every year for his neighborhood out in Thither Queens, and he hasn't allowed prison to cramp his style any. Last year's party was at least as big as usual, chock full of carousers, as well as food, drink and fireworks—and of course I was safer there than I'd have been in my own small apartment: people do not commit unwanted violence on Gotti's doorstep, and the immediate area of his home may be the most peaceful immediate a. within a thousand-mile radius.

I had never been to a Gotti bash; I was in fact doing the tourist routine. New Yorkers can be tourists here too—it's just that the sights are different: the Japan Air Lines origami Christmas tree, the Tibetan museum on Staten Island (but call first; they tend to open only by request), the spare Statue of Liberty (64th Street East of Broadway, on the roof of a building on the uptown side; it's smaller than the original, but I guess it would do in a pinch), and the Gotti Fourth of July.

The street was in full swing when I arrived about seven; this is a family party, beginning early enough for the kids. I grabbed an Italian sausage sandwich and an iced tea—and sort of filtered my way through the crowd, eavesdropping on a conversation here and there, mostly about the kids' school scores or a local grocery sale; peaceful neighborhoods tend to be dull neighborhoods.

Suddenly there was a bang and a hiss, and I was on the ground with my beard on fire. I did hear it—a fairly small firecracker gone out of control—and it did get me: I have had a good deal of Hospital and Rehab, but I am now a one-eyed man who has recently learned to walk all over again, damn it.

As for the one eye, if Odin can live with it I guess I can—but all this H&R is why I have been out of touch recently. I had some nerve jangles, too, and had to learn to type once more with my usual three fingers.

The beard has grown back, thanks.

And this adventure is what took me back to the Local University of New York.

LUNY is a small college (though there are those that love it, as Daniel Webster said about some other damn place), only the one building, but it's a truly big building. They have a sort of teaching rehab setup occupying part of the top floor (and they do have elevators, thank God), and a friend in Computer Sciences up there told me it was first-class. He turned

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out to be right, according to some other friends and kibitzers, so I signed on. Made an X, in fact, which made me feel like one of the Joads, but that was before I started to get my hands back.

Rehab is surprisingly mathematical: everything gets measured, and every little ratio has a meaning all its own. This letter isn't about Rehab, though—I'd just as soon forget it altogether; it's just that their math hooked in, at LUNY, with a section called biomathematical physics, and I got friendly with a Professor Inkling over there.

His whole name was Amadeus Inkling, and his specialty was the mathematics of butterfly behavior—which I admit sounds like an odd specialty, but the whole department sounds a little odd—very LUNY, in fact. Just the sort of thing you'd expect from a place that uses Poul Anderson's *Time Patrol* stories as a history honors course, or Charles Fort's "Lo!" as the text for a Probability course. LUNY isn't exactly like any other university I've ever heard of, and they're rather proud of the fact. Even the usual university structure, by the way, is a little strange: faculty tenure is voted by the students (from sophomore class on up through the graduates) and is re-voted every eight years. I don't say this is a good idea—I also don't say it's a bad one. But it certainly is a LUNY one, and there are more LUNY ideas than you might think, ideas that don't seem to show up anywhere but at the Local University of New York.

Inkling was a lovely fellow, if you discount his habit of quoting Mark Twain, or whoever really said that thing: Everybody talks about the weather, but nobody and so on. Charles Dudley Warner, if memory serves (my *Oxford Quotes* is still packed, because I'm unpacking one teeny bit at a time in order to be able to do the job without turning into a nervous breakdown product; I tell you, one firecracker can make for a surprising amount of chaos).

Whoever it was said it originally, Professor Inkling said it regularly. It did get tiring, but lots of things get tiring, and he was, once you had discounted the damn quote, a very nice change from Rehab. He knew some number theory, which has been my playground for a long while, and we traded divisibility theorems now and then.

But mostly it was the weather—I don't mean the quote, but the whole subject. Inkling had the idea that weather prediction ("in the very short term," he said) and weather control were both finally within man's grasp, and he didn't mean stuff like satellite predictions or cloud seeding: "Or anything really complex," he said one afternoon. "It is all going to be very simple, once it is set up—you'll see."

Well, people who think things are all going to be very simple usually have me backing away politely but damn rapidly—but Inkling had a sort of Nerd Magnetism about him. He was a reedy sort of fellow with sparse white hair that hadn't been cut in two or three years, and metal-rimmed eyeglasses that made his eyes look about the size of, say, the eyes on Whitley

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Streiber's visiting aliens. But he had this N. Magnetism; he was the sort of fellow who could persuade you that brown shoes would, too, come back into high fashion.

How it was going to be very simple to predict and control the weather he didn't say, and I mentioned, as casually as possible, chaos theory. "That started with weather people, more or less," I said. "The butterfly effect—one butterfly flaps its wings in Iceland, and weather patterns change all over the world. And you can't predict the butterfly."

"There are no butterflies in Iceland," Inkling said.

"St. Olaf drove them all out?" I said—Olaf being the coldest-weather Saint I could come up with offhand. Inkling just stared at me.

"St. Olaf was never in Iceland," he said. He had me there; I am not an expert on the Peregrinations of St. Olaf. Or anybody else; I tend to stay put, and assume other people will do the same.

"Iceland or Tierra del Fuego—and there's a good title for a Robert Frost poem hidden in there someplace—you still can't predict the butterfly."

Inkling smiled at me. It was the thin smile of a man who knows something you don't, and is sure that, when you find it out, you are going to be crushed flat by the surprise.

"We may not have to," he said.

Many scientists have this habit—it's a variation on the Royal "we," and when they say: "We may not have to," or: "We're making great progress," what they mean is the good old first-person singular. Inkling had the habit—picked it up from a Monarch butterfly, I shouldn't wonder.

"Why not?" I said, but I didn't get an answer, not then. Answers came later, as you'll see, along with a rather urgent request for your readership.

I suppose I ought to pay for an ad, and make the request there, but all this Rehab and such has left me temporarily strapped, and I have to ask you to oblige me, if at all possible, and run the request somewhere in the book. If you're planning any sort of What's New In Science article, as *Analog* occasionally used to, a few lines at the end of that would be a fine spot—I can't say for certain whether you're still doing this sort of thing, since Rehab was not conducive to *Analog* reading. Or any other sort—it's been a long while since I went gaily through a newspaper, for God's sake. And the request for your readers will come along when I've explained to you why I'm making it. All will be made clear; we just need a little patience here, OK?

But all that's to one side. Back to Inkling.

He was occupied, when I met him, in trying to find something that moved faster than an electromagnetic signal, and among many, many others I kept telling him there was no such thing, not in this space-time. Stuff that moves at the speed of light cannot be sped up any, no matter how hard you push.

He finally did give up on that one, saying sadly that light-speed would have to do, and when I asked him what sort of distances his signal would have to travel he told me:

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"Roughly thirteen thousand miles, at a maximum."

Light (or an electronic signal, if not an actual electron, which has actual mass) makes that in something like a fifteenth of a second, which seemed pretty fast for a trip four times across the United States, with a side-trip from here to Chicago thrown in as a frequent-speeder bonus.

After his flirtation with light-speed, he got curious about those spy satellites that can read your license plate, or diagnose your acne, from whatever number of miles up is the current record. He asked several LUNY professors if they knew any of the precise details of such satellites, from telescopes to comm links—hell, he even asked me, and I am not cleared for much beyond the *National Enquirer*.

What all this was in aid of I hadn't the faintest idea. I was doing Rehab—flexing my toes and getting the flex measured, lifting teeny weights and having my arm strength measured, such as it was, and even more repetitive chores—and chatting with Inkling when I was free and he could be found. He was spending a lot of time over in electrical engineering, though—to what purpose, again, I had no idea.

Not that I didn't ask him, but the most he would say was: "To anyone who understands chaos theory, it should be obvious."

I took that as a particularly vicious crack. I hadn't said I understood chaos theory, I'd just mentioned that there was such a thing. I've been through some popular stuff, but the real subject, the math, is some ways outside my ambit. Your readers are the people to ask, if you really want to know on that level; I've said for years that the readers are smarter than both of us.

But I went back to the pop works and read about the butterflies, and the orbits of the planets, and Fourier analysis (which seems to be what chaos theory is emphatically not about) and such things, and couldn't make them add up to spy satellites, speeds faster than light, and electrical engineering. I could see where weather might come in, but the books kept saying that nothing *could* predict weather very well—which is where I'd come in.

Inkling was talking about predicting it and controlling it. For a little while in there, I paid a lot more attention to Rehab, because it made more sense than the puzzle Inkling was being. But only for a little while.

Inkling was clearly up to something sizable, and, since I was in LUNY, there were very few limits on what that could be. Maybe, I thought, it was a business of controlling the weather by thinking good-weather thoughts and beaming them at light-speed to unstable air masses. That explanation sounded sufficiently LUNY, to be sure—I've told you a little about LUNY, Stan, but I haven't even mentioned some of the high points; next letter, maybe—but it didn't seem to cover all the bases.

Then I ran into a fellow from electrical engineering, and things began to make sense.

I mean I literally ran into him; wheelchair management is not much

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like leg management, and takes some getting used to. I was backing out of a traffic jam in Rehab (three wheelchairs and what they call a Gerrychair, a sort of near-horizontal wheelchair setup for geriatric patients or others who can't sit up), and ran over the foot of a man standing behind me. It's a lot harder to look behind you from a wheelchair, and I didn't happen to have a warning beeper.

I apologized and he made light of the event and one graceful sentence led to another, and I mentioned Inkling's interest in Electrical E. "I know," he said. "He's a nice enough fellow, but he's been a terrible bother; he wants us to build a mechanical bird."

"A what?" This new piece didn't fit any of the other pieces.

"Well, not a bird," he said. "A butterfly."

"That one word," as Holmes once told Watson, "should have told me the whole story, were I the ideal reasoner you are so fond of depicting." And were I the ideal r. myself, it certainly would have. I'm sure Holmes himself would have had no trouble moving from spy satellites to mechanical butterflies (given a short course in both, since he has had no certified cases since 1917). The notion of mechanical spies shaped like butterflies, one immediate mental construction, is perhaps just a little too James Bond for consideration, though I did consider it for a few minutes. Not enough space for data collection and transmittal, I thought, and dismissed it.

Not, I'm afraid, the ideal reasoner, but which of us is? I mulled over Inkling's butterfly for some time, never getting to ask him about it because he didn't show up much for the next few days, and when he did he was almost totally abstracted—wherever the essential Amadeus Inkling was, it wasn't where his body was located.

And by the time I did find him in, so to speak, and got ready to ask him what the hell was going on, I didn't have to. He told me.

The whole grand scheme took my breath away, let me tell you. I have run into some large schemes in my time—there was that whole business of making strawberry-flavored envelopes with just the faintest touch of LSD, back in the '60s, and there was one mad scientist's idea of adding subliminal messages to all Talking Books (he wanted to turn us all into vegetarians, pacifists, and other uninteresting people)—but I think Inkling took the cake that one afternoon.

We were sitting in one of the Rehab gyms (not too much like your usual gym, but they smell the same, thanks), and Inkling announced, without preliminaries: "I have done it."

"Done what?" I said; with Inkling I always seemed to be the straight man: How hot *was* it? "Fixed the weather?"

"Everybody," he said, "talks about the weather, but nobody does anything about it." He gave me a big, big smile. It looked odd on that face; behind the glasses his enormous eyes crinkled, and he looked like a Whitley Streiber *jolly* visiting alien. "I," he said, "have done something about it."

I suppose I shouldn't have, but I couldn't resist saying it: "Bought an umbrella?"

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He didn't take umbrage and stalk away; he was too damn happy to take any umbrage at all. "I can predict and therefore control the weather," he said. "Finally and absolutely. Have you ever noticed (for instance) that New York is littered with drought warnings when our reservoirs are low, and we are then called upon, idiotically, to welcome any passing bucket of rain that falls here—many miles from the reservoirs?"

I'd noticed that, and been as irritated by it as everybody else. I said so.

"Now," he said, "it will rain into the reservoirs. The city, as it should, will stay nice and dry for us."

"Great," I said. "Got any other improvements?"

"Hurricanes, tornadoes, typhoons and all the rest will no longer be worrisome. They will occur in designated Storm Areas, varied from week to week but always over large bodies of water. Ships and planes will be warned to stay clear of a given week's Storm Areas."

"And?"

"Spring will be spring again, and autumn autumn. It might even be possible to do something about global warming, though that development is still in work."

"It sounds wonderful," I said. "Just how is all this going to be accomplished? Or is it accomplished already?"

"It requires money," he said. "Large, visionary money." And he explained it to me.

Not then and there; the gym was filling up with grunting, sweating people. We went to the LUNY cafeteria (a nice place, wheelchair-accessible—do you know, by the way, that many federal post offices aren't?—and full of good, if odd, food—I'll tell you about it some time) and he drank coffee and I drank some and spilled some, and he laid it all out for me.

Which brings me to that request.

What Inkling needs, and I think deserves to have, is the hell of a lot of development money. In order to make his scheme work, he needs a great deal of cash with which to underwrite the construction of thousands of mechanical butterflies, each equipped with a comm unit—and a network of communications stations with links to the global net of weather satellites. (It develops, as you probably know, that I was wrong about the amount of space required for this; miniaturization has come a long, long way, and what you can write on the head of a pin these days is the *Encyclopedia Britannica.)*

It's his feeling that ten thousand mechanical butterflies will be enough, but he admits that the figure may not be quite right. "The problem is susceptible of fairly simple analysis," as he says, "and it's just a loose end that will be tied up fairly soon."

But I don't think the world should wait even an hour longer than it has to for complete weather prediction and control. I think we should go for it now, and support Inkling's system. A medium-sized contribution from every reader would do the job nicely—something more accurate than "medium-sized" will get to you in a

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few days, when I have some final figures from Inkling.

Stan, he really does have something here—and it's the answer to most of the difficulties chaos theory keeps mentioning, just by the way, at least as far as I understand chaos theory.

(And why can't he apply for a government grant? Two reasons: first, LUNY never takes any government money, being a little afraid that the government would then step in and alter the place—a stance I think is perfectly reasonable—and second, the government is being very chary about grants of any kind these days, what with the Balancing Budget Side Show, among other things. No, this has to be private money—every contributor to be a shareholder in the eventual company, of course, which may be an added spur to interested readers.)

And what is his scheme? Its simplicity is just staggering.

Somewhere (not in Iceland), a butterfly flaps its wings, upsetting weather patterns all over the globe and making real weather prediction (and therefore control) out of the question; nobody (we assume) can track every butterfly.

But, with the help of spy-satellite technology built into the mechanical butterflies, you can. Assign each mechanical butterfly a fairly small space of that part of the world which has butterflies in it. Key the butterfly to report instantly on the movements of its real-life cousins.

Then duplicate the movements—in reverse—with the mechanicals. When the butterfly goes east, the mechanical goes west; when its wings flap up, the mechanical's wings flap down.

Just as with some new sound-deadening systems, the reverse motion will cancel out the original motion (we won't have to fly the mechanicals as low as the originals—the differences in air density, wind and so on can be allowed for, and a capable computer system can vary the duplication as needed).

The result will be a world of simple, predictable weather patterns, entirely free from the butterfly effect. And prediction does mean control here; weather-control, once you're sure of the weather, isn't terribly complex to set up.

(I said, by the way, that this notion smoothes out a lot of the difficulties pointed at by chaos theory—and it does. All we need is enough money, for instance, to build Negative Planets [and Negative Asteroids, to be sure], and we can regularize the Solar System perfectly. Other applications will doubtless spring to mind—they certainly keep springing to mine.)

Inkling's Negative Butterflies look like a giant step forward for humanity—and I think you'll agree, Stan, that they are a truly LUNY concept. ■

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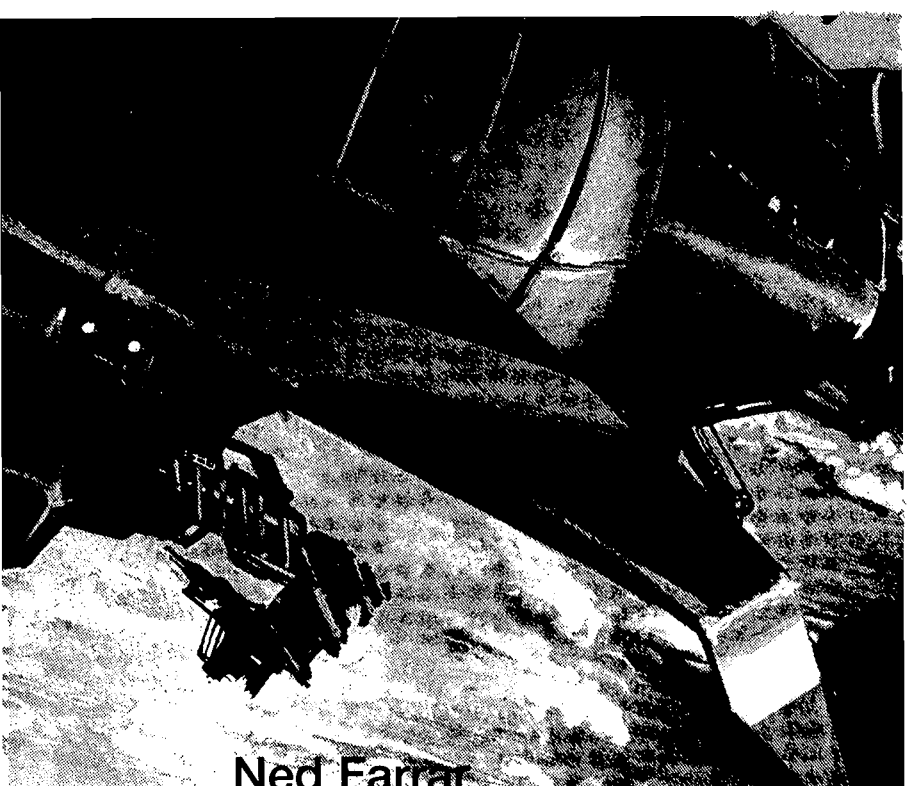

Ned Farrar

BEYOND THE VOLCANO

It's easy to concentrate so hard on the problem at hand that you don't even notice the problem you should *be working on.*

Illustration by Nicholas Jainschigg

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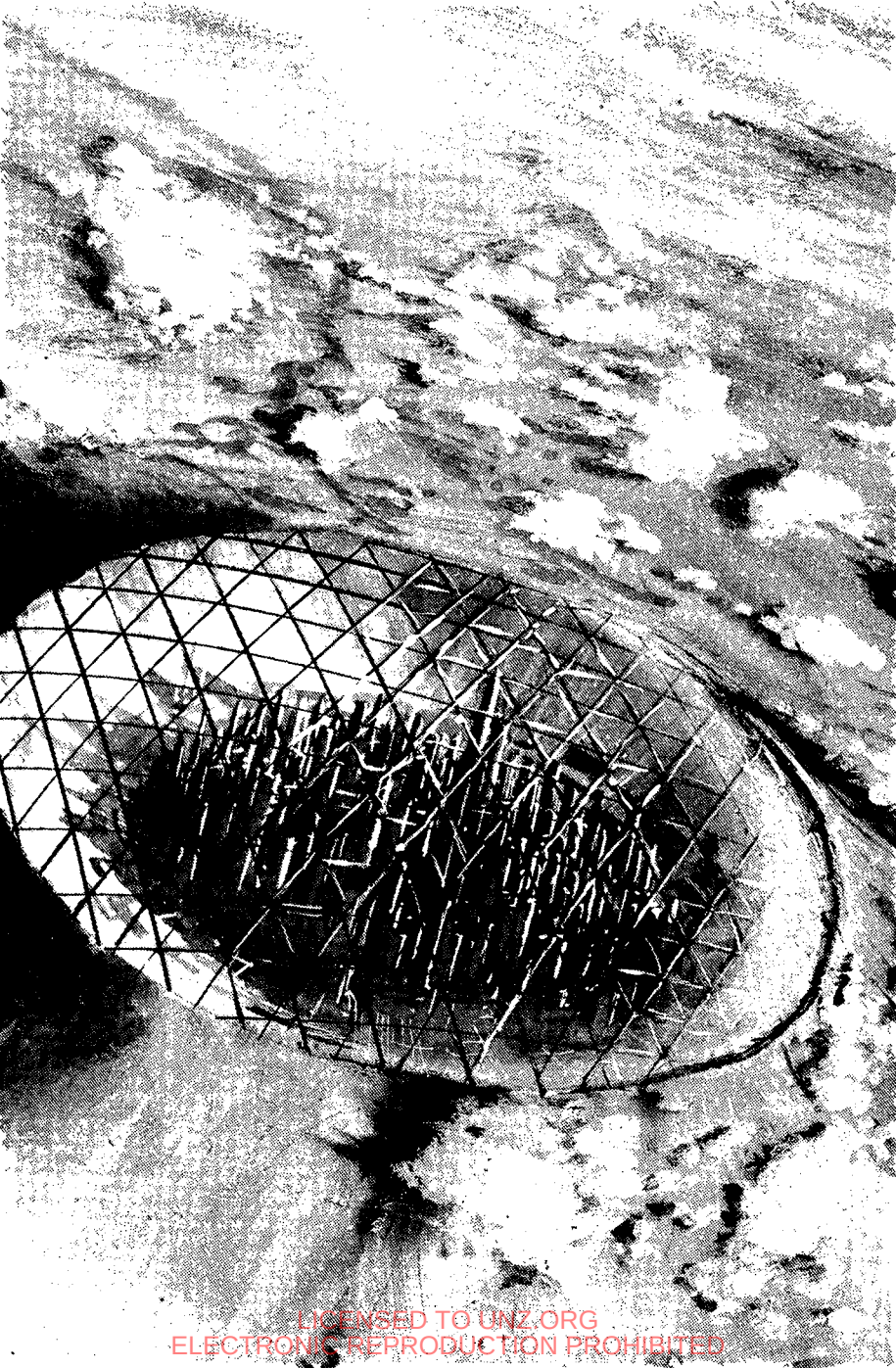

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"Its name is Hawking Mons, but to those who live in the domed-over crater it's just the Volcano. I still find it hard to believe that one of the Galaxy's natural wonders is known by such an ordinary name. Volcanoes aren't uncommon, after all. Every sizable world has a few. But only Marjolin in the Epsilon Indi system has a Hawking Mons: an extinct shield volcano over 1,000 kilometers broad at its base; towering 56 kilometers high—so tall, it pokes through the blanket of acid clouds which shroud the planet's surface, like an island emerging from a hot poison sea.

"Marjolin is an Earth-sized, rocky world orbiting too close to its stellar primary to be habitable. Atmospheric pressure at the bottom of its gravity well is equal to what you would find about a thousand meters beneath Earth's oceans, and it's hot enough down there to melt lead. But pressure and temperature decrease with altitude, and at the top of The Volcano it is a perfectly pleasant 23 degree Celsius, nice autumn weather back in Washington. It would have been nicer if the creative forces of the Universe had made it breathable too . . . but that would be expecting too much. It's almost all carbon dioxide, and at that altitude, even Marjolin's ultra-dense atmosphere has thinned to what you would find over Earth at say, 15 kilometers.

"Hawking Mons Habitat itself is as remarkable as the Volcano. I've seen domed-over craters here on Luna that are as large, we all have. Copernicus is much larger than Hawking Mons habitat, but on Luna, one does not have Earth's gravity to contend with. On Marjolin, one very nearly does. Nevertheless, the E-Indi Enterprise had decided it was necessary to create a terrestrial-type environment within the system—to be a rest and relaxation station for Oort miners and their support personnel who would be stationed for years at a time in the vicinity of Epsilon Indi. Building the dome on the Volcano seemed the lowest cost solution. Notice I didn't say most cost-effective. Cheaper doesn't always mean better, not even when cost is a major consideration.

"It is important you understand this, if what I am about to say is going to mean anything to you at all. . . ."

1

A checkerboard floor paraded with regiments of empty plastic chairs. An odor of cleaning fluid in the air. Somewhere beyond my early morning brain-fog, it was dawn.

I was alone in the ground terminal, the other passengers having all dispersed at the starport to points in the outer system where significant economic activity was taking place. I had made the drop down Marjolin's gravity well as the only living payload in an automated shuttle pod, arrived only minutes ago. . . .

". . . Passenger Shade Sansouci please come to the Controller's office. Will passenger Shade Sansouci please come to the. . . ."

And already I was being paged.

I hate space travel. Long ago, it was

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considered adventurous—but that was then, this is now. Now it means bad food, long periods in hyperspace when nothing happens, and stomachs upset from velocity changes during final descent. Add circadian desynchronization to your probable list of aggravations, since every planet has a different length day, and you have the "adventure" of modern space travel. And I since I am senior VP for Crisis Management in Weltverbesserungswahngesellschaft, once I arrive anywhere, I am always immediately rushed into action to deal with *the crisis,* whatever that happens to be.

Now, after five shunts through hyperspace and an interminable descent from Epsilon Indi's Oort Cloud, I at last had my feet firmly planted on terra firma, and of course it was starting just as it always did. I had been hoping this time it might be different. Hawking Mons Habitat's reputation as a bohemian paradise, whose people the promotional literature describes as "True Sybarites," had not seemed consistent with the urgently vague coded message which had brought me here.

I obtained directions to the controller's office from one of the information downlinks in the passenger terminal, and saw with chagrin that it was a SHARATEK model installed and operated by Sharawaggi Information Technologies Group. The whole Hawking Mons project had been one long tangle of administrative disputes between us and the Wags.

The *Big Word,* as we like to call it, has contracts designing and maintaining ecosystems on dozens of worlds, Marjolin being one. And because Hawking Mons Habitat is so small an enclosed ecosystem, about the size of Rhode Island, the Big Word pretty much runs the whole show. We were government in all but name here, since nothing would live for very long without us.

This made the message which had called me here just that much more unusual. No one screws around with the people who make their air. But I had a feeling that I would soon find Sharawaggi at the bottom of it.

Otis Fremont, our local Ecotechnical Operations Team Leader, was waiting for me in the controller's office. He had obviously gone native, and was wearing what looked like baggy blue paisley-patterned pajamas. Even at his best, Otis looks like Einstein having a bad hair day. The clothes exacerbated his eccentric appearance. I almost burst out laughing when I saw him, but stopped myself as I saw the controller, sitting bored behind his desk, was similarly dressed. It was I, in my layers of dark Earth-style clothing who looked out of place here. I made a mental note to acquire some local attire after I'd settled in.

"Shade! Good to see you again! What's it been . . . ten years? How is your lovely wife . . . ah . . . Anastasia?"

"Ana and I have been divorced for sixteen years, Otis, remember?" I long ago gave up expecting Otis to remember much of anything outside of his field which was also his passion. A master ecologist of the old school, he could identify thousands of birds by their calls, or walk into a patch of woodlands, name all the different flo-

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ra by their smell, and know which were sick from what pollutant and how to repair the damage. He could visualize ecosystems holistically without using computers and nonlinear analytic programs. So far as I was concerned, he was as valuable as an ironclad contract with unlimited cost overrun provisions. I'd personally sacrificed—a lot, on one occassion, just to keep him from being stolen away by the competition. But he could seem hopelessly befuddled to anyone else.

"That's right, I remember now. Your current wife is June."

"June is my daughter, Otis. She lives with her mother in Chernobyl. I had a fiancée, but that's over now."

"That's right, I remember. June. She's well?"

"Last time I checked, they both were, and I do hope Lulu is too, but Otis, am I correct in assuming you didn't call me in just to talk family?"

"Oh no, certainly not, Shade, certainly not. It's Wag business again. That's why I wanted to meet you here rather than communicate by hyperlink with Earth or anywhere else. I'm sure they monitor our communications. That is their turf. I expect them to take every advantage."

This was not paranoia on Otis's part. Sharawaggi ran all the Habitat's information systems: the entertainment net, computers, and all communications. Since no real work could be done without their services, they often acted as though *they* were the de facto government of Marjolin. I was quite prepared to believe their people were monitoring our people's off-planet communications, probably our intra-office chit-chat as well. But that still didn't tell me why I was here.

"Otis, what is it that requires my attention?"

"It's Sharawaggi's new development plans for the western quadrant. They've somehow persuaded the habitat Administrative council to approve a VR Entertainment Complex to be built right in the Soyinka Patera wetlands. The dome has only a few thousand hectares of permanent wetlands. And Soyinka just happens to be the only breeding area of any significant size for the anopheles population in the dome. Redevelop Soyinka, and we will lose for sure. The long-term cascade effect would be considerable. We've got to make that clear to the council."

I considered that for a second or so before responding. One of the less appealing aspects of my job is coming to the defense of nasty little bugs like the anopheles *mosquito*.

Nobody likes mosquitoes, myself included. They are at best annoying as they buzz about one's face and ears. At their worst, they are vectors for disease—anopheles in particular had an unsavory history on Earth of spreading malaria. If it were possible to construct an ecosystem without them, I would heartily approve. Only people like Otis can think of good things to say about mosquitoes: that in both their larval and adult states they are the principal food source for other species that in turn sustain thousands more. The rest of us don't think in terms like cascade effects, and accelerated entropy in closed systems—un-

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til we have to pay for it. By then it's usually too late.

Coping with the interconnectedness of nature is the first and most important step in ultimately utilizing it to our best advantage, but throughout history that has been the hardest step to take. Back in the twentieth century, timber harvesters rarely considered that one minor effect of their logging would be increased sunlight reaching the forest floor, warming the waters of countless brooks flowing through it. If that did occur to them, they didn't take the next mental step, and recognize that this would damage or destroy river spawning grounds for ocean-dwelling fish. They did not connect their work to reduced fish harvests thousands of kilometers away. Nor did they consider that each reduction in forestland also reduces the volume of biological filter purifying groundwater, leading to increased levels of contaminants discharged into the local water supply; or that loss of predator habitat leads to explosive growth in the population of undesirable insects and small mammals, who in turn. . . .

You see how it goes.

Of course with a whole planet at one's disposal it's easy to overlook such things. The larger an ecology is, the more damage it can simply absorb. Whole species may go extinct, but an overall equilibrium will reestablish itself and, for the survivors, life will go on. But the ecosystem under Hawking Mons Habitat's dome covered only about 3,000 square kilometers. When Otis said loss of mosquito breeding grounds was a threat to the integrity of the system as a whole, he wasn't speculating on developments in the distant future. He meant the threat was immediate, and that Weltverbesserungswahngesellschaft, as the prime contractor charged with maintaining a stable ecosystem under the dome, would end up paying for it. Ultimately this cost would be passed on to the Enterprise, and from them to the dome's inhabitants, but that could take decades. It would be small comfort to shareholders whose dividends suffered in the short term.

"Otis," I sighed, "it would be nice if just once our problems centered around some cute furry creature people actually liked."

Otis and I left the terminal in a quaint little red trolley. It actually rolled on wheels along two steel rails going click-click, click-click—no superconductors, no maglev technomagic, it was obsolete technology pure and simple. The designers of the dome's internal transport system had decided quite deliberately to reinvent this antiquated vehicle. After all, its only reason for existence was to create a place for rest and relaxation. The planners felt the slower pace of life imposed by old-fashioned technology would contribute to this.

As it left the tunnel which connected the ground terminal to the habitat, it wound its way down a track in the side of the crater wall giving us an unobstructed view of the interior. Above me, I saw a pale blue sky, crisscrossed by the delicate triangle traceries of the dome's geodesic frame.

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Below, was the lush tropical green of the crater floor. Outside the temperature might compare to Washington in autumn, but inside that giant greenhouse, it was more like Bombay. Hot humid air rose, losing moisture as it thinned and cooled at higher altitudes, forming clouds. They seemed to settle in smooth, misty strata over the Habitat's large central lake, its surface mirrorlike, undisturbed by even a hint of breeze. And around the lake grew a forest like an ocean of emerald leaves foaming with flowers.

On planet after planet where the Big Word has contracted to manage some part of the environment, ecosystems are utilitarian, designed only to serve the basic needs of settlers. Flowers exist because pollen must be carried about by insects to ensure genetic diversity in successor generations. But in here, flowers exist because they are beautiful, and Otis and his team had perfected an ecosystem designed to maximize both their brightness and numbers. Bougainvillea and honeysuckle, orchids and lilies, magnolia and jacaranda grew in profusion spilling scent and color into the still air. Each was a triumph of genetic engineering, found nowhere else in the Universe.

One reason the designers had been able to conceive and create such a whimsical ecosystem was that the habitat was not expected to sustain a large population. Only about 20,000 people actually live here. Perhaps a hundred times as many transients will pass through in a terrestrial year, but none stay very long. The dome doesn't need much agriculture or industry. It is the kind of place people like Otis dream about. A vibrant living world of species complexity interwoven to form: *magic.*

But working people on vacation want to do more with their leisure time than smell the flowers. They want restaurants and dance clubs, bordellos and "VR Entertainment Complexes" to either stimulate or relax them, and conveniently separate them from some of their hard-earned cash so the Enterprise can recoup a portion of their salaries without being accused of underpaying anyone.

The Big Word doesn't handle that sort of thing. The Wags do.

To be fair, I should say the Wags don't actually go out of their way to damage the environment in the name of mindless entertainment. But much of what they do requires substantial infrastructure. They must string powerlines about the dome's interior to run the many services the Enterprise expects them to provide. If they bury them underground they upset Otis by destroying earthworm habitat. Run them overhead, birds suffer.

Once, after years of debate and planning, the top brass at both the Big Word and the Wag had agreed on a corridor between Southern and Northern settlements to be developed as a transport and electrical power artery. Then Otis came out with a report showing that electromagnetic fields produced by the high voltage power cables Sharawaggi intended to run down it, would alter the daily peregrinations of some hummingbirds who were important pollinators, and so . . . not surprisingly, the Wags

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thought we had been negotiating in bad faith. A lot of acrimony resulted.

The corridor went through. Both road and powerlines were built. And Otis, as usual, turned out to have been right. We're still trying to reestablish some aesthetically pleasing flora in the regions hummingbirds no longer visit.

It was one more example of how fragile the ecology under the dome really was. Given a whole planet, not even Otis would have been overly worried about hummingbird interaction with EM fields. But here, in this tiny world sealed in a bubble, every part must work perfectly for the ecosystem to survive. And every time the Wags began some project that involved digging, building, or just making loud noises, something in that system was affected.

"Otis," I asked as the tram descended, click-clicking slowly toward the crater floor, "how is it that plans for this complex were able to get this far without your knowing about it?"

"Mmph. That's the most disturbing part of it, Shade," Otis replied. "The Wags have taken to circumventing the environmental planning process entirely. They design projects without even bothering to do an impact study, then just walk them over to council and get them shouted through. This is not the first time—it's just the biggest, and the first to have a high probability of major cascade effects. See the tower over there?"

Otis pointed across the crater to where Southern Settlement's arcology emerged from the center of a perfect circle of agricultural land. A blue needle-like spire had been built at its southwestern corner, disrupting the structure's symmetry.

"They built that in only seven days. They already had the materials they needed stockpiled before they went to council with the plans. By the time I finished my first analysis of its impact, it was already complete. Fortunately, there was nothing to worry about. It's part of an established human residence area, it interferes with no migratory or precipitation patterns. It's ugly, but if the settlers want it, who am I to object? But this trend of the Wags, of not submitting their plans for study by us—that is where things started to go wrong.

"I know I should have put my foot down sooner, with that tower, in fact. It's not that I would have wanted it stopped. I just shouldn't have let the precedent be set. They did it nine times, and I did nothing. That tower; one like it in Northern Settlement; some light industrial developments which the settlers really like, also in Northern Settlement; and a childrens' educational facility down there in Southern. Good projects all, with no significant environmental impact. I wouldn't have objected. But they end-ran them around me . . . said I would only delay things. Said council could make up its own mind. Called me 'an obstacle to progress' and other untruthful things. . . .

"And now they are going to do it to Soyinka Patera! I am sorry Shade, I ought to have acted sooner. I didn't think the Wags would go so far so fast with so little thought behind it."

"You say they had materials stock-

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piled before they made the proposal?" I asked rhetorically. Otis might be mystified by Sharawaggi's behavior, but for me it was starting to make sense.

"Yes. They didn't even announce they were bringing anything special in—just added it all on to their regular shipments of maintenance supplies. . . ."

"Otis," I interrupted him, "it sounds to me as though the Wags have coopted at least some members of the council. They wouldn't have dropped hardware down this gravity well if they hadn't already known they'd be getting the necessary OKs."

Otis thought about this.

"Those first nine projects were pretty unobtrusive," he finally said. "If they already knew the impact on the environment would be minimal, then it wouldn't take a genius to see that the settlers and their council would look upon them favorably. They might just have gambled and won."

"The first couple of times maybe," I said. "But I'll bet next quarter's entire dividend that this all fits together as part of a single plan. And I'm not sure even the VR complex is the end of it. They're pushing the limits on their freedom of action with something big in mind. The fate of your mosquitoes is going to be insignificant by the time this is over."

"It's a lot more than just the anopheles, Shade! You know that! We could lose. . . ."

"*Money,* Otis. This company could lose a lot of money if we have to restabilize the Habitat's ecosystem with one fewer insect species. But we will pass that cost on. Ultimately council will end up paying for it. And if any future increases in council appropriations wind up being tied convincingly to one of their projects, then Sharawaggi will suffer some future retribution. *The Wags know this.* So why risk it? Why put so much effort into a project which they know will cost them in the future? There must be something bigger at stake here. What is it?"

2

"I hear your Mr. Fremont is concerned about our Soyinka Patera Project," said Cheri Millefiori, Director of Sharawaggi's Marjolin field office, as she slipped languidly through my door and settled uninvited onto the couch in my quarters. She wore a slim anklet of tiny gold bells which jingled as she walked. That had been my only warning she was coming.

She had not even identified herself, but I had seen her picture before—I even had a copy of our own dossier on her sitting there on top of my desk. I arranged to drop Otis's atmospheric impact report on top of it, just in case she decided to sashay over and have look at the hard copy I'd been studying.

The dossier picture had not done her justice. Ms. Millefiori was the most beautiful woman I had ever seen. Her long, golden hair was looped in a braided crown about her head, and she walked with an erect grace evocative of ancient royalty—projecting self-confidence verging on arrogance. Her curvaceous figure was barely contained by the gossamer wrappings of a sari, opalescent as a butterfly's wing. Even the asymmetry

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of the jeweled stud in one nostril seemed to call attention to the perfect line her nose drew between lips and forehead, which in turn lured one into looking into her deep dark eyes. . . .

I assumed her clothing choice was part of a deliberate effort to ensure I was hormonally distracted when I first met her. I also decided the plan was working.

"Do you always pay surprise visits on newly arrived corporate goons like myself?" I ask abruptly, not wanting to surrender total control of the meeting. "And doesn't Sharawaggi corporate etiquette include such niceties as knocking before you enter someone else's quarters?"

"That's right, you're from Earth," she sighed, "where there are locks on doors and all that. I must apologize to you then. I was born here in the dome. We are much less formal, you know. 'True Sybarites' according to Enterprise promotional literature. We enjoy life too much to be always on the defensive.

"If you'd like, I can leave and come back later . . . maybe even make an appointment or some such thing? You do use that procedure on Earth, don't you? Request an appointment. Make sure you're on time so the person you're visiting can demonstrate his superior position by making you wait—all the social dominance games Earthers consider necessary, before *doing* anything?"

She had a point, but as an Earther, I had no intention of conceding it.

"Now that you're here," I grumbled, "you might as well stay. And yes, Mr. Fremont is concerned, both by the environmental impact of the Soyinka Patera project *and* with the fact that a project with such a clear and significant impact was designed, and taken to council with no study being done."

"We did our own study," she said simply. "We know all about the impending demise of several million mosquitoes. We frankly saw that as nothing to be alarmed about."

"You know full well that there's more at stake than mosquitoes," I retorted, and gestured towards the sheaf of flimsies I had been reading when she entered. "Since I assume you have as little respect for the privacy of my colleague's computer as you do for my rooms here, I imagine you hacked in and read his reports while he was still working on them. But just in case you didn't, let me mention a few of the other variables you are ignoring. One: Soyinka Patera is the only sizable wetlands area under the dome not immediately adjacent to the central lake, and is the primary biological filter for the aquifer which provides water to Nothern Settlement. Was council made aware that without it they'll have to begin artificially purifying drinking water within the next twenty years as a result of your project? There's no mention of it in the council minutes."

"The technology required to filter drinking water has been available for centuries. It is not expensive. It is not difficult to maintain. It will not be a problem," she said, and smiled a slight bewitching smile. She had red lips, like rose petals. It occurred to me that they had been colored, a custom

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long discontinued on Earth and most other worlds in the settled Universe.. Here the custom seemed to have made a comeback. The look was exotic, and stimulating. . . .

"Then there's flooding. Wetlands serve as reservoirs for excess precipitation. The ground simply soaks up the water. Drain that ground, harden it and the water must go elsewhere. Did you mention that the likely collection point for millions of liters of newly released water per year will be in the foundation levels of Northern Settlement Arcology and the agro-hectares surrounding the township? Again, there's no record of it in council minutes."

"And again, technology to deal with such problems is simple, inexpensive, and readily available. Council will not be called upon to pay for a thing. Extra water flowing into agricultural areas may result in different crop choices being made by farmers over the next few years. But they will make them spontaneously without an act of council. Rice is as good a crop as maize. And if basement dwellings need to be mopped or bailed more often than is customary now—well, it is not a serious concern. The effect of water on polystone foundations in a climate without seasonal temperature variation is nil. No structural damage will result. The victims you think we are creating will be unlikely to even notice they were being victimized. Life will go on, as stultifying as it always has for them."

She spoke without a trace of concern. She'd known the points I was going to raise before I did—clearly she had been reading Otis's reports straight out of his computer.

"And the physical structure of the dome itself?" I asked. It was a calculated risk. Otis had not yet written anything on the impact of Sharawaggi's project on the structural integrity of the dome, yet it was clear to me from his atmospheric analysis that there would be an increase in stress on its skin.

"What do you mean?" She asked coolly.

She was good. I had caught her off-guard, and she wasn't letting it show. There was no apprehension in her voice, but she failed for the first time to immediately offer a rebuttal.

"Air," I said, "expands when it's heated. The dome must therefore be able to expand too. E-Indi rises, air warms, dome expands, E-Indi sets, and the dome contracts again as the air inside cools and occupies less volume. This expansion and contraction must be closely monitored since over time material fatigue can create microfissures in the dome's skin, which may widen into a catastrophic rupture.

"Water serves as a heat reservoir during the night. E-Indi sets, and water slowly radiates away the heat it absorbed during the day. The reason the Habitat's designers insisted so much interior surface area be covered by water was to exploit this moderating effect in reducing wear and tear on the dome itself. Keep interior temperature reasonably constant, you reduce the need for surface maintenance and chance of accident. But you're draining the Soyinka wetlands. The volume

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of water under the dome will remain the same, but its surface area will be reduced—and so will its effectiveness as a temperature moderator.

"You'll create more extreme temperature differentials between day and night. Not enough to impact on inhabitants' comfort, perhaps. But enough to increase stress on the skin of the dome. The cost of that could be enormous."

"And how long do you think it will take before that cost needs to be considered?" She asked. Her face remained impassive, but her eyes held me in a very close scrutiny. I didn't know if she suspected yet that I had no data. Not that my basic facts weren't correct, I just didn't have any quantitative analyses of the degree to which tinkering with the dome's water supply would alter the structural dynamic rhythm of its skin. Here was where I had to be careful.

"About twenty Earth standard years," I lied. "Statistical probability of a major structural failure begins to increase rapidly after that."

And I noticed an immediate change in her.

As I had been talking, she had been—not visibly tense, she was too good at controlling her body language for that—but she had been immobile. The moment I said twenty years, the bells on her ankle jingled. She had relaxed again.

"Then I don't see a problem," she said.

"Why not?" I asked.

"I was born here, Mr. Sansouci—or may I call you Shade?"

"Stick to Mr. Sansouci until you know me better. But I don't see what this has to do with the problem you're in the process of creating. Surely, if you're a native-born Marjolin, you've got enough attachment to your home to not want it destroyed?"

"Oh, now, we are not really talking about destruction, are we? Just increased maintenance costs. Costs which everyone who lives here expects to pay anyway. We don't walk around with calendars in our heads, though, marked for when the next payment will come due. Twenty years is a long time in a place like this where nothing ever really happens. When the cost you speak of finally does come due, it will be seen as just one more of many associated with living here. We're all used to that by now."

"You don't speak as though you care much for life here."

"What is there to care about? It is the only life I know. It has its good points, but I don't get to hop from star to star the way you do. The dome is pretty. Outsiders like to come and admire it. But there is not much here, just entertainment for transients. That is why we developed our sybaritic lifestyle. You've heard of it, have you not? It is a response to boredom."

She rose gracefully from the couch and stepped over to where I sat. With one delicate feminine finger she drew a soft line along the bridge of my nose. I felt it right down to my groin.

"You should be warned, Mr. Sansouci, that we dome sybarites shift quickly from one subject to the next. And we don't have many interesting men around here."

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I responded to her touch by drawing her towards me. I know back on Earth they would have I said I let her take control of the meeting, but I was no longer interested in the fate of the anopheles mosquito. We kissed, a long lingering kiss filled with promises, and adjourned to the bedroom where her sari and my pajama-like attire wound up intertwined on the floor. In lovemaking she combined both lust and elegance, and I was conscious of little but the pale silkiness of skin, her hot breath on my cheek, and the jingling of the little bells about her ankle.

Eventually she touched her rose-petal lips to my ear and whispered: "May I call you Shade now?"

I woke the next morning to see E-Indi's light pouring through the windows, bright as sunlight on Earth would have been expected to be. Cheri Millefiori, still unclothed, stood looking out.

"Somehow, the phrase 'transit of Venus' has just popped into my mind," I said.

She turned, presenting a tantalizing silhouette. I still could not see her face, she was so strongly backlit, but I could hear the smile in her voice.

"How sweet of you to use astronomical metaphors in describing me to me. How would you describe yourself to yourself?"

"Not astronomically, that's for damn sure. You know that in about an hour, I'll have to be in our field office thinking up ways to make your life miserable?"

She laughed and walked slowly towards me, the delicate jingling of her anklet's bells marking each step.

"And I suppose you will tell them all about tonight and try to derive some special advantage from it?" she said.

"I doubt there'd be much point in that, would there? It strikes me you're unlikely to be embarrassed by anything which happened tonight even if it does give new meaning to the phrase going to bed with the opposition."

She lay down and kissed me on my forehead.

"Try as we sometimes might, we of the dome can never take competition so seriously as you Earthers. Listen to yourself. You are here. I am here. And you are still thinking about business. Let the day take care of itself. There are other opportunities in life worth seizing in the here and now."

The word "seizing" seemed particularly appropriate, but still curiosity made me delay. I could not believe she was able to so completely divide her private and professional lives like this.

She returned her attention to my forehead, kissing me lightly on the bridge of my nose, once on each eyelid, and on my mouth—then we came together with as much passion as we had the night before. But I still could not rid myself of the suspicion that I was being used in some way I had yet to understand.

One hour later, I found out. I arrived at our field office to find Otis in a panic and the rest of the staff sitting in paralyzed disbelief as the most easy-

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going team leader in the Universe ran about shouting, tearing his hair, and grabbing things off other people's desks to throw against the walls.

"Shade! Thank God you're here! I've been trying to reach you all night but your comlink was in *call-reject* mode. What were you doing?"

"Otis, I'm not going to tell you. Let's just say I had a visitor and didn't want to be disturbed. What is the emergency?"

Otis had obviously not slept all night. He was even more unkempt than usual, the blue paisleys wrinkled and sweat-stained.

"The Wags began construction last night! All the equipment they brought in for earlier projects . . . I was a fool not to notice—it was far more than they needed and it never left after they were complete! They stockpiled it! Now they've run all their 'dozers at once through the patera! A spoiler strategy, trash the land first so it can't be preserved, then on to the development stage. They've done it! Damn them, they've done it!"

"Calm down, Otis! Calm down. So they've done it—you knew there was a helluva good chance they'd do it anyway. Why act surprised? Your next job is to figure out how to restabilize the system without anopheles. My job is to figure out what's really going on here. There's no way in hell that all this scheming and sneaking about after dark can be motivated by the desire to build a VR Entertainment Complex. There's got to be something else, something the Wags will go great lengths to do covertly."

Otis still looked as though he wanted to continue destroying office implements, but I knew he could never resist a challenge. In a few hours, he'd be completely wrapped up in redesigning the habitat's ecology to survive without mosquitoes.

"And Otis, use an isolated terminal. The Wags have been reading your files. Any system we have which is part of the dome's network has been compromised. Until we've got a better idea of just what's going on, security's a priority."

"Work without the 'net? But Shade, that'll . . . that'll . . ."

"Make everything much harder. I know. But at least they won't know what we're planning before we ourselves do. So we work harder. So what? That's what we get paid to do.

"Also, while you're doing that, we're doing our own snooping. I need an I-tech operator—one who's a damn smart hacker."

3

Honolulu Loki still had the round face and girlish smile that disarms instantly. I should have known the only hacker Otis would trust for this job would be his wife. He usually regards people who interface with technology for a living to be members of an enemy nation. Except Lulu, who had taken possession of both his gonads and his soul sixteen years ago.

OK, I confess. I told her to do it—it was my sacrifice.

She'd been fresh out of the service then, newly made civilian after ten years as an I-tech Ops Officer aboard some starcruiser out on the fringe. She'd been twenty-five, very pretty,

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and we'd been . . . acquainted . . . until I had learned that Villeggiatura, S.A., one of our less principled competitors, was going to offer Otis a chief conservatorship in one of their projects out around 61 Cygni. Lulu had been involved in something not quite legal in our Copernicus office, which I'd caught her at, effectively ending our relationship. But she'd agreed to do me this favor in exchange for my losing certain files. And now here she was, sipping absinthe and smiling at me over the lip of the glass. It was almost like old times, but not quite. It's hard to catch one's deeper mind reevaluating a past decision, especially in a crisis when one is trying to focus elsewhere.

We were sitting in a small restaurant with the improbable name, "Ragougnasse á Gogo," built in a large treehouse looking out onto the central lake through a tangle of leafy boughs. I'd wanted to meet away from the office. Not only were Otis and his team already working with that blindly frenetic zeal which creates a sense of total chaos for anyone not part of the project, but I thought our conversation might just drift into areas her husband didn't need to know about.

Lulu wore a wig of colorful anodized aluminum beads, hanging down below her shoulders. I think the fashion world calls the look "techno-Egyptian." She'd always covered her naked scalp—like all service I-tech Operators, she'd been depilated so the interface skullcap wouldn't have to read the electrical activity of her brain through an insulating layer of hair. And bright colors set off her smooth coffee-no-cream complexion very well.

Like Otis, she'd gone native, and wore a sensuously draped gown of knitted silk the color of fresh snow. It flowed about her so loosely, that it would have been quite impractical in any environment where even the gentlest of breezes might blow. She'd gained weight, and was probably dressing to conceal the extra kilos. She probably wouldn't have been as sexy as Cheri Millefiori in a sari, but she still looked good to me.

Fate can be a quirky thing. I'd expected her sex appeal to give Otis one more compelling reason for staying with the Big Word and eschewing other offers. I hadn't expected the marriage to work out so well. None of mine ever had. But here they were, sixteen years, three kids later, and I couldn't even remember what it was I'd caught her at anymore. I could remember feeling certain pangs at giving her up to keep Otis, though.

"Have you tried cracking Wag systems before now?" I asked.

"Same old Shade, eh? Always the action-man, still moving and shaking your way across the Universe without even saying hi?"

"OK . . . hi . . . and I hope your husband remembered to tell you how beautiful you looked this morning."

"Oooo! That's a new Shade. I think I like him! And of course he didn't, he's Otis Fremont, remember? The most important ecotechie this side of 61 Cygni. That's one of those things old Otis never remembers to say."

"Well then I'll say it, Lulu. You look

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terrific. Really. But, *have* you tried cracking the Wags' systems?"

"I never had any reason to," she replied coyly, and let her lips touch the glass again. And I knew she had, reason or not.

I looked her straight in the eye, but my fierce penetrating stare didn't stand a chance against the disarming smile.

"How much success did you have?" I asked as I surrendered.

"More than they'd believe, somewhat less than you're hoping."

"Well, it still sounds promising," I said. "I need to know what's really going on with that VR complex. Stands to reason they've got a data trail somewhere that'll tell me what they're ultimately shooting for. Think you can find it for me?"

"Maybe, maybe not. You may be assuming too much, Shade."

"Why?"

"The Wags have their own unique way of doing things here. Protecting data with walls of sophisticated security isn't part of their usual modus operandi. They prefer plain old sleight-of-hand to keep things secret. Like bringing in all that extra equipment to build nine small projects, so it'd all be ready for the Big One. I'd cracked their security screens on every single one of those. I knew what they were bringing down and when. But I never thought to check and see how much of what they brought in was actually used on each project—why would anybody? That's how they like to work it down here.

"If I hack in and find a really well-protected data-store, I can work my cerebellum into jelly, and maybe I'll get inside. But when I do, I'd be willing to bet next month's salary the data I finally download won't be worth a damn. The whole store with all it's security will turn out to have been created just to keep me busy, and keep you barking up the wrong trees while the data you really needed was staring you in the face all the time."

I thought about that. It made sense. Since the Wags were themselves the masters of computer hacking here in the dome, they would naturally be aware of how vulnerable even protected data-stores could be. Then it hit me. . . .

"What do you mean, 'the Big One'? Do you have reason to believe they're not planning anything bigger after this?"

"If they are," she said, "they haven't brought in equipment for it. Remember, I did crack their files on those first nine projects. I know what they brought down, and now that I know to look, I also know what they used, and what they had left over after each one. They already have their VR Entertainment Complex right here, in the dome. It's in pieces spread about several warehouses, but it's all here. Nothing else is. This is the Big One, so far as the Wags are concerned. Everything they've done to date has been cover for it, and after it's complete there'll be no spare parts left to be used in anything else."

"I find it hard to believe they'd risk as much as they have for a VR Entertainment Complex. There must be more than that."

"I agree," she said seriously. "And

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the only explanation I can think of, that makes any sense at all, is that the VR Complex itself may be more than it pretends to be. . . ."

The architects' plans for the *Soyinka VR Entertainment Complex* were easily obtained through the habitat's Public Records Department. I accessed them from the terminal in my quarters and spent a couple hours perusing the designs looking for clues, trying to pinpoint something special in the physical structure of the building which might explain its importance to the Wags. I found nothing. In fact, the only unusual thing about this project was the rather odd nature of the "entertainment" it was being designed to provide.

Virtual Reality has been the backbone of the entertainment industry since it was invented four centuries ago. Continuously refined and improved, it can create a fantasy environment in cyberspace so real that VR addiction has become a serious problem on some worlds—people enter Virtual Reality and forget there even is a "real" reality to which they must return. Commercial programmers now design deliberate imperfections into their sensory simulations to combat this. And most VR entertainment can be accessed through the 'net in one's home or hotel room, so it doesn't require a special facility being built. But the Soyinka project was different. The promotional literature billed it as: "VIRTUAL *REALITY,* NOT VIRTUAL REALITY."

Far from participating in some fantasy entertainment program, the participants were supposed to be "enabled through the miracle of modern cyber-technology to explore the true surface of this most interesting of planets, Marjolin."

Inside the Complex would be 1,000 cells in which humans could interface with man-sized automatons deep down in the crushing atmosphere, below the yellow clouds of sulphuric acid which flow about The Volcano like an ocean. There, where Epsilon Indi's light has been filtered into a diffuse glow the color of antique parchment; where blood-réd sunsets last for hours, paying customers will "walk" on the vast basalt plains, and "reach down" to feel gritty scalded regolith slip through surrogate fingers. There will be mountains to climb, sheathed in soft metals which sublime into vapor in Marjolin's lowlands then precipitate out at cooler altitudes: peaks covered in lustrous antimony snowcaps; slopes cut by copper glaciers; with avalanches of lead, and blizzards of arsenic. And there will be canyons to descend, even volcanoes the VR explorers can enter, walking to the very margins of the lava flows. And it will all be *real.* People "jaded by the easy fantasy of standard VR fare will re-discover the romance of being human in the wide unknown, beyond The Volcano."

The copy writing was very good. I almost believed it myself. But I hadn't noticed any decline in the popularity of standard VR fare lately. Corporate futures were still selling high, and if people were becoming jaded, they were doing a good job of not complaining about it. And I couldn't quite

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see Sharawaggi actually filling 1,000 interface-cells with paying customers even during the holiday season—face it, the surface of Planet Marjolin may be "untrod by human feet," but by itself that is only of limited novelty value. It is also a depressingly barren wasteland. Who's going to be so excited about walking on scorched sand and broken rocks that they'll actually spend money on it more than once, for maybe an hour? Especially when there is a crystal clear lake to swim in, to say nothing of beautiful, bored sybarites looking for "interesting" partners to alleviate the ennui of paradise. I could not believe the Wags expected such a venture to turn a profit.

I was meditating on that, trying to envision a good reason to go out on a limb to build a project that could only fail, when my comlink buzzed. I switched it on, and Lulu's face appeared in the screen. She had her interface skullcap on, and was obviously in her office plugged into her terminal.

"Mr. Sansouci," she said with exaggerated formality for the benefit of eavesdroppers. "I thought you would like to know, I have successfully accessed the system you were interested in and there is a large, well-protected datastore there. It's file title suggests its contents might be of interest to you."

"Excellent, Ms. Loki," I replied slowly, remembering what she had said this morning: *If I hack in and find a really well-protected data-store . . . I'd be willing to bet next month's salary the data I finally download won't be worth a damn.*

"Ms. Loki, I'd like you to crack that file very carefully. . . ."

And let them know, I thought, *keep 'em guessing, while I try to figure it out from the data staring me in my face.*

". . . And let me know what you find. How is Mr. Fremont doing with the restabilization plans?"

"He and his ecotechies all looked pretty happy when I last saw them," she said. "I didn't get all the details, but I understand the worst cascading imbalances in ecosystem integrity can be postponed about a hundred years by simply introducing rats and cockroaches into the habitat."

"Rats and cockroaches?"

"That's the current most favored option, as I understand it."

"No poisonous snakes? No scorpions?"

"None were mentioned."

"Ms. Loki," I sighed, "could you please kill your husband for me—nothing cruel, just a pillow over his face while he's sleeping, perhaps?"

"I'm afraid not, Mr. Sansouci," she said laughing, a sound which triggered memories. "Not that I haven't been tempted from time to time, but there are the kids to consider."

"Oh well. Some men are just born lucky. I'd like you to keep me informed on this and . . . that other matter."

"I certainly will, Mr. Sansouci."

"Let me know how things are going tonight," then, driven by a reckless urge, I added: "Drop by personally, if you can, just like old times . . . perhaps."

Her eyes widened slightly at that,

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but then she smiled her disarming smile, and said she'd "take it under advisement."

I didn't have long to wait before the 'link buzzed again. It was Cheri Millefiori, smiling seductively and dressed in a new lemon-colored sari flecked with green batik dragonflies. It was as though she were calling on cue, which she probably was.

"Well, Shade . . . I can call you that now, can't I? I thought if you were feeling bored with your anti-progress activities, you might want to come on out to Soyinka Patera and take a look at Marjolin's future in the making—strictly professional meeting of course. But I think it will be both useful and stimulating."

"Of course," I replied, "I can think of no better way to spend my afternoon, now that I've got my troops busy in defense of ecological sanity, trying to spoil your fun and profit." And we arranged to meet in front of the Sharawaggi offices and share transport out to the construction site.

4

It had rained while I was reviewing the public records. Not a heavy rain; habitat weather is relentlessly gentle. There's not enough convection in the interior atmosphere to produce even the most minor of thunderstorms, but umbrellas are still sometimes useful. "Rainfall" is more like congealed humidity, descending softly in droplets just large enough to trigger tactile awareness, until the patina of the soil changes darkly and flower petals become lustrous with tiny jewels of moisture.

Across the flagstones of the pedestrian boulevard, shallow puddles with mirror-like surfaces reflected criss-cross traceries of the sky above. I shattered reflections into ripples with the soles of my sandals as I walked splatterfully, resisting the urge to skip, thinking that all this scene really needed was a little lame balloon seller whistling far and wee.

The dome was working its magic on me. Its environment was too perfect, too serene, to let anything interfere with living. Not even a senior VP for crisis management could resist the urge to slow down, relax and smell the flowers.

I had the center of the boulevard pretty much to myself as I walked across the arcology's courtyard. The natives were engaging in their social walkabouts mostly under the Moorish arches of the arcade which encircled it. A few people strolled in the open, decorative umbrellas under their arms, smiling and greeting each other familiarly. Barefoot women in iridescent saris walked carefully holding the trailing fabric away from the damp ground, or daintily lifted the hems of loose flowing gowns ankle high. Men like me had less care for our baggy pajamas, and it usually showed in the damp cuffs of our trouser-legs.

Sharawaggi Information Technologies Group occupied several levels in the southern end of the arcology, right in the shadow of the towering blue glass aiguille which Otis said in retrospect had been the first sign of our present trouble. Cheri was there, standing beside a groundcar, accompanied by a towering blond man in a sarong, who seemed to have been

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carved out of mahogany by a sculptor dreaming of Aryan supermen from Tahiti. She introduced him to me as Mr. Izvoschik, the driver.

"Driver?" I asked.

"Yes," she replied with her usual scornful nonchalance. "The habitat's creators held to their belief that obsolete technology was more relaxing than the kind which just does what it's told. There are no smart-transport vehicles under the dome. You need to hire Mr. Izvoschik, or somebody like him, if you ever want to leave the beaten track and go anywhere off the trolley routes."

"No bags?" Mr. Izvoschik spoke.

"No, not today, Mr. Izvoschik," Cheri replied. "This is just a day trip out to Soyinka Patera. Our usual route, please.".

The Aryan superman dutifully held the groundcar's door while we boarded, then folded himself into the seat ahead of us and began working the controls. We slid smoothly forward, with the vehicle emitting a barely audible electric hum. Our speed translated itself into the first wind I'd felt since my arrival, and Cheri shook out her meter-length golden hair, letting it trail like a pennant behind us, a look of rapture on her face.

"I love to feel a breeze," she said. "I'm sure it's an ordinary thing for you, but in here it is an exotic experience."

I really couldn't think of a response, so I remained quiet. I was once again struck by how much contempt she seemed to have for the dome and all things in it, despite being herself such a quintessential Marjolin, a perfect specimen of "True Sybarite."

"Oh look!" She spoke again as we rounded a corner leaving the confines of the courtyard, "That's where I was born!" And she pointed to a terraced bay of elegant balconies and florid arches cast in dyed polystone. Cursive letters executed in sinuous tubes of electrically charged neon glowed over the main entrance, one more example of the aesthetics of anachronism.

"Agapemone?" I asked, thinking: *abode of love?*

"Yes, up in the second tier. Growing up, I was a member of the *ballet rose*. You should visit it during your stay here. I may be a bit biased, but I think it offers the most refined service of any bordello under the dome."

"I'll take that under advisement," I said, deciding that might explain a few things about Cheri Millefiori. Our dossier had omitted details like this. It had told me only that she had been born here in Southern Settlement, and when. Until now, I'd had no information to give me insight into her character.

"It was a very good place to grow up in," she said, perhaps sensing my thoughts. "And a good place to make contacts too. Sharawaggi needed staff who knew the dome inside and out to run its operations here. People truly connected to this planet, not just visiting. I was the person they needed. *Agapemone* is where I succeeded in convincing the right people of that."

As she was speaking, she put her arm across my shoulders, and leaned her head against my own, nuzzling me behind my ear. Not even the breeze of our vehicle's motion could

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blow away the scent of spicy fragrance which she had applied to her skin.

"Wasn't this supposed to be a strictly professional meeting?" I asked, internally ordering my hormones to sit down and shut up.

"You are a curious man," she seemed to hum through a smile rather than speak out loud. "I know, and you know I know, that you enjoy life just as much as I do and in all the same ways, yet you divide your life into compartments—time for business, time for pleasure, one time for love and another for ambition. It's like you have a special habitat dome built into your psyche isolating the good things within its bubble while the rest is reserved for dust-and-acid storms. I don't think I'd like to live that way. You throw away too much that just happens to offer itself to you on the wrong side of the bubble-wall."

And the light dimmed as the groundcar passed beyond the margin of Southern Settlement's agro-hectares and plunged beneath the flower-filled canopy of the cloud forest which Otis's skill kept growing in this part of the habitat. The scent of orchids and wild cloves breezed past us, and scores of azure-and-scarlet hummingbirds flitted through gaps between the trees in pursuit of nectar. Cheri left her warm lips against my ear, and we both became silent as we were swept past a Bird-of-Paradise singing its weirdly erotic ululating song.

We emerged from the forest half an hour later and began the shallow descent into Soyinka Patera. The air became tainted with the odor of rotting ferns and other dead things. Graceful dragonflies zipped about the wreckage of the wetlands looking for prey in the deep ruts left by the heavy dirt-moving equipment's wheels. Papyrus and cattails had been crushed into soggy mats of floating green, and in one place it seemed a stampede of frogs had erupted from a dying marsh pond, only to be murderously flattened by a passing vehicle. All that remained was a slick organic pavement across the road.

If she'd wanted to impress me with "Marjolin's future in the making," then this was probably not the best first impression to give. But if the director of Sharawaggi's Marjolin field office wanted to dispel once and for all any notion I might have had that these wetlands could be saved, it was a brutally effective strategy. I was glad Otis wasn't there. He would have cried.

But I had never had any illusions about the salvability of the patera. The Wags had put too much effort into getting this project past the point of no return. It couldn't be reversed now, and it probably couldn't have been stopped even if we had acted sooner. By hook or by crook, this VR Entertainment Complex was going to be built. And in and of itself, that made no sense. I asked myself again, why would they go to so much trouble for a project which any marketing research team would have identified as a failure from the word go? The only explanation which made sense was the one Lulu had offered back in *Ragougnasse á Gogo*: "the VR Com-

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plex itself may be more than it pretends to be."

That, and the Wags' strategy of hiding things in plain sight, and then trying to keep me looking in the wrong direction, were the key ideas I needed to remember while I was here.

Cheri straightened and stretched, ostentatiously displaying her anatomy beneath the speckled gauze of her sari.

"Smells horrid, doesn't it?"

"Marshlands aren't usually beloved for their aroma," I replied, "but I doubt the 'dozers have done much to improve it."

"Not yet," she agreed, and began rummaging about in a small compartment built into the back of the driver's seat, "but give them time, and you'll never know there ever was a filthy swamp here. Most of it will be terraced bougainvillea gardens. The complex itself will fill the center of the patera, over there to your left. The architects have designed it to be a fusion of ancient Mayan and Egyptian styles, you saw the renditions in the public records file, I trust?—Yes, of course you did—here." And she handed me an aerosol container filled with clear liquid.

I shook my head, marvelling at how unselfconscious she was about revealing to me the fact that she was monitoring all my access to the habitat's information net.

"I'm too attached to Earth mores to wear perfume," I said.

"This isn't perfume. It's mosquito repellent. Trust me, the moment this vehicle stops moving, you are going to need it."

I took the proffered bottle and began spraying my face and arms. The vehicle came to a stop beside a jumble of steel roofed equipment operator's sheds. Outside, the operators themselves were taking an early afternoon siesta. They were mostly young men and women in their twenties, wearing shapeless sweat-stained work coveralls. All looked like recent ex-service types—more debutante civilians with hairless heads and honed interfacing skills so much in demand these days for terraforming jobs and other heavy work done primarily through sophisticated remotes. They were obviously not Marjolins. None had the languid grace which was so typical of dome inhabitants. I had noticed even Lulu walking with a trace of that languor, as I watched her cross the floor of the restaurant towards my table that morning. And I noticed one of the operators who looked heart-stoppingly like the young woman I had sent away so long ago—to seduce Otis into sticking with the Big Word when another firm was about to offer him an opportunity I'd known he'd jump at. She had the round face and girlish smile. . . .

Then she turned to exchange words with another operator, breaking the spell.

"Well, here we are," Cheri said as she stepped out of the open door, "at the birthplace of tomorrow's Planet Marjolin."

I followed her out, offering polite thanks to Mr. Izvoschik for playing doorman, and getting no response. The ground was squishy and wet. Mosquitoes buzzed annoyingly about my ears despite the repellent. I also

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soon discovered that I'd forgotten to spray my feet, and the nasty bugs began feasting on my toes and ankles. Cheri watched me fruitlessly slap at my attackers several times before turning to ask the driver to wait by his groundcar, assuring him we wouldn't be staying long.

"Now I know you won't find all this equipment as fascinating as I do," she was saying as she led me towards the main control office in the center of the village of squat little sheds, "but you must see how the pulse of activity just runs through this area now. Developing the Soyinka Patera swamp into such an exciting project will be the most important thing to happen on Marjolin since the Volcano itself was first domed over by the Enterprise more than two-hundred years ago."

"Killing an important stabilizing force in your ecosystem in the name of an advertising slogan like, 'Virtual *Reality*, not Virtual Reality,' does not exactly strike me as such an epoch-making event," I replied, stepping carefully to avoid the deeper puddles as I walked. Fortunately, once we left the road and were among the metal sheds, we were on ground which had already been drained and had large grey polystone flags laid across it to provide better footing. Sand had been spread about as well, and foot traffic had worked it into the irregular gaps between the flagstones. It was not an attractive bit of landscaping . . .

Well, I thought to myself, *this part of the project is only temporary. Once it's done they can rip up the flags and transform this wasteland into something living.*

. . . In fact it rather reminded me of the barren basalt slabs and gritty regolith which covered the plains and valleys of the planet beyond the Volcano: the dead landscape Sharawaggi's promotional literature insisted tired working-people on vacation would want to pay for the privilege of visiting by remote—

"That slogan was my idea, Shade! Honestly, why shouldn't reality be more interesting than fantasy? People leave the Oort mines and the Starport and drop down our gravity well all the time to visit this claustrophobic little bit of heaven, just because they know it is *real,* not simulated. If fantasy could have satisfied them, they would have stayed out there and run VR simulations for every activity they can do here. Reality is a commodity for which there *is* a demand, Shade."

But I wasn't listening. I had turned and watched a 'dozer trundle by on the road. Somewhere, in one of the operator's sheds, someone was not taking a siesta. Instead, plugged into their machine, skullcap snugged tight, seeing through the 'dozer's "eyes," feeling the texture of the ground beneath its wheels—someone was experiencing through Virtual Reality, the *reality* of the work underway in Soyinka Patera. . . .

"Shade?" Cheri queried tentatively when she saw I had stopped following her lead, and begun looking at things on my own.

. . . And I remembered Lulu saying the Wags would be hiding the truth right in front of me. She probably hadn't meant it this way, but my mouth twist-

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ed into a knowing grin as I saw shiny membranes stretched over each shed to reflect heat up and away from the structure beneath—and I thought about how on Earth, polar ice-caps reflect the Sun's rays, preventing the arctic from warming, even during the six-month's daylight of summer. Then I looked up at the criss-cross skeleton of the dome and tried to feel the weight of the air it contained pressing down on me. Earth had once been as dead as Marjolin, until its oceans soaked up most of its carbon dioxide and cyanobacteria converted still more into limestone and stromatolites, releasing the oxygen which the rest of the living Universe needs, remaking a world.

"Shade, I wanted to show you our construction schedule with its online targets and . . ." I was tuning her out. Lulu was right, it was all there, right in front of me all the time. And now that I could see it, no sleight-of-hand could hide it from me again. A dozen equipment operators will remake Soyinka Patera in a matter of days—what could 1,000 do?

"I need that many, you're right," I said.

"What?"

"To do what you're gonna do. You'll need 1,000 heavy equipment operators. But I don't understand all the why's and wherefore's yet, so you'll have to tell me. You and I have some serious negotiating to do this afternoon Ms. Millefiori. I hope you're authorized to do it."

I strode purposefully past her, and entered the main control office, listening with satisfied ears to her panicky footsteps behind me in pursuit.

5

It was dark by the time I returned to my quarters.

The negotiations had not been easy, and had gone on all afternoon and into the evening. First Cheri Millefiori had tried evasions, then she'd become belligerent, losing her temper—going so far as to accuse the Big Word of planning to infest the habitat with rats and cockroaches as part of a spoilsport scheme.

Eventually she had caved in, and we set up a multichannel meeting in the main control office between ourselves and some senior *comitadjis* at the Enterprise and worked things out.

I was feeling pretty good for the close of my second day on a strange planet, and it occurred to me as I came up to my door, that Marjolin's day was an almost perfect twenty-four hour period like Earth's. This meant I was suffering none of the usual circadian problems that make planet-hopping such a miserable experience. Yet another asset this planet possessed which had been staring me in the face all along without my noticing it.

E-Indi had dropped behind the lip of the crater about an hour ago, but the streets were well lit, and in a world where doors have no locks, coming home late is not much of a problem.

Then I saw the beaded wig draped over the back of a chair.

"You did say just like old times, Shade," I heard her voice from the bedroom. "And just like old times you're always late, running around

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with another woman."

Sixteen years can change a lot. She was not the same woman I had briefly romanced then given up so long ago. She was heavier now with a mother's breasts and fine laugh lines around her eyes. But Lulu still moved under me with a voluptuous excitement which made my heart pound until I could feel its drumlike pulse in my ears, and warm throbs rippled through me. When I finally withdrew and lay beside her, all I could think was what a fool I had been to give her to Otis. I tried to imagine her having spent those years with me—the kids would be mine of course, and I'd awaken to her magical smile, the patriarch of my happy little tribe. . . .

"So, am I still as good as you remember?" She whispered, rolling to face me. There was a soft glow in her eyes, and her face had become glossy in the sultry night air. She touched me, relaxed fingers gently raking the warm dampness of my own chest. A well-remembered caress.

"Better," I said, which was true. "I was just thinking what a fool I was, asking you to keep Otis for the company, instead of keeping you for myself."

It was a stupid fantasy, really. None of my marriages had lasted for more than three years. If I'd tried to keep her, I'd just have one more ex-wife by now, and maybe another child I saw once per decade or so. These are the choices I always managed to make. Lulu certainly knew that just as well as I did. But she was willing to play along.

"In that case Otis junior would be a Shade junior and would take after his father: preparing himself to be one of the movers and shakers of the Universe, while twelve-year-old girls get weak in the knees when he looks in their direction."

"Shocking," I said. "The boy needs a more moral upbringing."

"And Loki-Arrabella? She wouldn't be chasing butterflies at age eight . . . she's busy practicing her intimidating stare—the one that lets other people know they should click their heels and say *yessir!* to you as soon as you stop speaking."

"Much too driven. Kids should have fun while they can. What's kid number three doing?"

"You don't remember?"

"Remember what?"

"His name is Shade."

"Oh." I guess Otis, or Lulu herself, must have sent a message at some time telling me, but I had never absorbed the fact.

"He's only six, but he's very good with VR dexterity games. I think he'll grow up to be a data-jock, like his mother."

"Good for him," I said.

"Is this what you really wanted when you asked me to come over, *just like old times?*" She changed the subject.

"Yes. Did you think I didn't?"

"No, I was pretty sure you did. I just didn't know until I got here myself, if I really wanted to. I'm glad I did, for old times' sake . . . but I don't think we should make a habit of it. I've gotten used to being married to Otis. It's comfortable, and I like him. I don't want to unnecessarily complicate that."

"Otis is a very lucky man."

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"I know. I think he deserves to be a chief conservator by now. You're going to remove him from this position, aren't you?"

That surprised me. I had just come to that conclusion myself only a few hours ago.

"What was in that data-store?" I asked.

"I wouldn't know, I never cracked its security. But I'd hacked that particular slot of files before, and it never had a damn thing in it until after you arrived. Then up pops this motherlode data-store with bells and whistles attached to every access node, just begging to be attacked. It's a plant. It was just supposed to keep you busy. But I don't need to hack into their system to know that whatever the Wags are up to here, it involves a lot of money. Money they don't want anyone talking about. I'm sure you've got it figured it out by now—and negotiated the Big Word in for a piece of the action."

"I have to think of the company's interests."

"I'm not saying you shouldn't, Shade. Remember, I know you." She smiled, then rolled out of bed and padded into the next room. There was no seductive jingling of tiny bells, just the friendly pat-pat of bare feet on carpet. After recovering her wig, she returned and began to dress.

"The E-Indi Enterprise intends to terraform Planet Marjolin," I said. "The deal could be worth trillions. How much the initial offerings sell for will depend on how far advanced they are with the technical end of the project when the shares hit the bourse. Sharawaggi, for a price, agreed to work as a front for the project. The VR Entertainment Complex is intended to be the nerve center for planetforming ground operations. They'll be using those cells just the way it says in the promo, only it won't be entertainment. They'll be building big reflectors down below, to simulate ice-caps and help cool the surface. They'll bring down water from the Oort, and bubble Marjolin's air through it like a giant fishbowl to speed its absorption of carbon dioxide. It's been done before, but never on a world this close to Venus-normal. There've been some recent advances in technology, however. The people in the know believe it's finally possible.

"If the brokers know the Enterprise has that kind of convertible capacity already in place, shares'll sell high. Epsilon Indi's only 11 light-years from Earth. A new habitable planet that close to the Core can expect to be the fastest growing settlement area in the Galaxy in no time."

"I'd have thought the rapid capital growth they'd derive from that would be good for the Enterprise. Why keep it secret?"

"Good for the Enterprise does not necessarily mean good for everyone associated with the Enterprise. There are individuals involved who stand to make a great deal of money by buying low, before the bourse generally realizes what an asset the VR Complex is to the project, then re-selling high after the word gets out. The Enterprise will get its needed capital, but certain VIP middlemen will de-

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rive their own benefits first."

"I see, and Otis is not likely to keep quiet about this?"

"Otis . . . probably wouldn't understand the financial ethics being circumvented here. It's just not the sort of thing he'd focus on. But he'll cry blue murder when he finds out what's going to happen to the habitat. Once the atmosphere of the planet has been reduced to terrestrial norm, the Volcano'll be poking right up into Marjolin's mesosphere. Outside atmospheric pressure'll be less than a millibar, temperature'll drop to minus seventy—maintaining its current internal temperature will be an expensive proposition. So it'll get colder inside too . . . much colder, arctic cold. It'll be impossible to maintain a tropical ecosystem here. If the Enterprise decides to keep the dome at all, it'll most likely be for use as a giant warehouse, inflated with argon at only a few hundred millibars of pressure. But they probably won't even keep it for that. Hawking Mons habitat will just cease to exist.

"Otis needs to be taken out of here, so that he loses the temptation to figure out what is going on. What he doesn't know won't hurt him, after all."

"Sounds reasonable to me," she said, vanishing beneath a cloud of knitted silk which settled in satiny contours over the warm curves of flesh which had filled the hollows of my palms just minutes ago. I wanted to reach out and pull her back to me, but I could sense that thin bubble-wall which divides the time for love from all the other times in my life, and I knew she really didn't want me to ignore it, "So where are you going to have Otis sent after his promotion?"

"I think Planet Serengeti could use a new conservator—"

"A new *chief* conservator."

"A new chief conservator. It's a long way from the Core Worlds, but it is a whole terraformed planet which has been set aside for gene banking. They need to maintain an extremely complex ecosystem with niches for highly specialized life forms being squeezed out of the more developed worlds, but which might be useful someday in terraforming projects and ecological repair jobs. Its biological diversity is even greater than Earth's. . . ."

"Oh, Otis will love it!"

"I can't make any promises." I said.

"You don't have to. Remember, Shade, I know you. You're one of the movers and shakers in this Galaxy. If there's enough money at stake, you'll get the board of directors to give you whatever you want. Otis will finally get the chief conservatorship he deserves.

"I've got to go now. He'll be back from the office soon, and with kids—well, little Shade has been known to wake up in the night after a bad dream, and come looking for his mama. . . ."

"Lulu, if this all works out, I would still like to see you again—maybe in less than ten years this time?"

She smiled, gave me a kiss, and told me she'd take it under advisement, before walking out my lockless door. I watched her go again, wondering who it was this time who'd actually gotten all they wanted out of our dealings. I didn't exactly feel like a mover-

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shaker at that moment.

". . . Cheaper doesn't always mean better, not even when cost is the major consideration. It is important you understand this, if what I'm to say is going to mean anything to you at all.

"The domed habitat in the crater of Hawking Mons was the lowest cost solution to a specific problem. However, in the long term it costs an unacceptable amount just to maintain so delicate a closed ecology, and it can only be done by consciously under-utilizing the most valuable resource in Epsilon Indi's inner system: a terraformable world. The lowest cost solution is not cost-effective. It is time we consider that fact, Boardmembers.

"Nature left Planet Marjolin a Venusian wasteland. But we have the knowledge and technology to change that now. The . . . agreement I have concluded with representatives of both E-Indi Enterprise and Sharawaggi Information Technologies Group will guarantee Weltverbesserungswahngesellschaft's place as the Prime Contractor for the entire planet, with unlimited cost-overrun provisions. *And given the delicate nature of some of the information now in our possession, I think we can safely say this contract is iron-clad.*

"In view of this, I suggest to you that it is in our mutual best interests to let events unfold as originally planned.

"And I expect each and every Boardmember will agree that promoting Mr. Fremont to Chief Conservatorship of the Serengeti project is the most cost-effective long-term way of ensuring that all involved parties share in the expected benefits of developing the fallow planet, beyond the Volcano." ■

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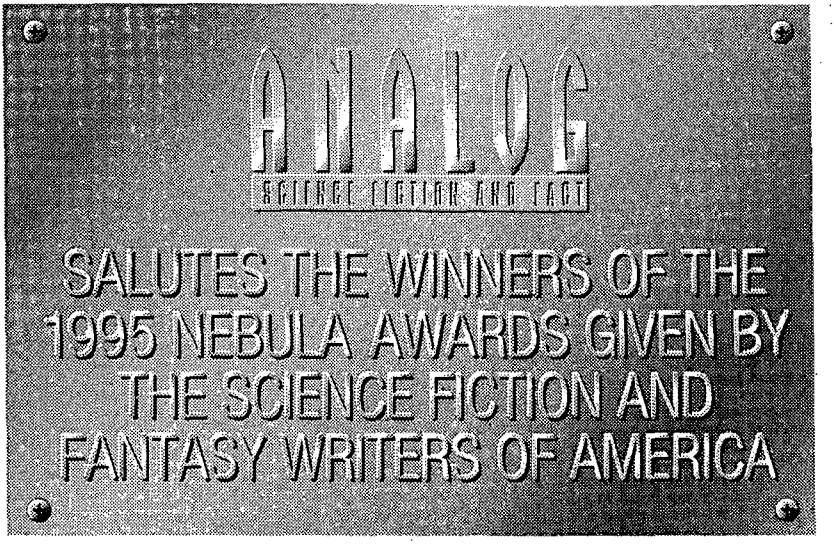

Best Novel

THE TERMINAL EXPERIMENT

by Robert J. Sawyer

(serialized as *Hobson's Choice*, 13/94-3/95 *Analog*)

Best Short Story

"DEATH AND THE LIBRARIAN"

by Esther M. Friesner

(12/94 *Asimov's*)

Best Novella

"LAST SUMMER AT MARS HILL"

by Elizabeth Hand

Best Novelette

"SOLITUDE"

by Ursula K. Le Guin

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INSIDE THE QUARK

The hot physics news for February 1996 was the composite nature of the quark. In a paper submitted to the journal *Physical Review Letters,* 450 members of the CDF group at Fermilab reported indications that the quark may have internal substructure. This is the first evidence that the quark is not a fundamental particle, but instead may be made of sub-particle components. This may be the breakthrough that transcends quantum chromodynamics (or QCD), the present Standard Model of particle physics. Experimental particle physics may have "struck gold," the first such strike in a long time.

CDF (the acronym stands for Collider Detector at Fermilab) is the experiment that in 1994 and 1995 suggested and then confirmed the discovery of the top quark, using 1.8 TeV collisions of protons with antiprotons at the Fermilab Tevatron. To assemble convincing evidence for the top quark, the CDF group collected data from a large number of proton-antiproton collisions during the 1992-93 running period. Then, with the top quark safely salted away, the CDF group has been examining their accumulated data for other aspects of the pp collisions. One such study of the CDF group focuses on "jets" from the pp collisions. "Jet" is high-energy physics jargon for a cluster of high energy particles emitted in the same direction.

Free unattached quarks are not permitted by the rules of QCD. Within the colliding protons, the constituent quarks are tied together with gluons that form "color strings" connecting the quarks. If a quark strikes another quark in a head-on collision and is ejected from its surrounding proton, its attempted escape from this confinement stretches the string until it breaks, with a new quark and antiquark forming at the broken string ends. The resulting multitude of new quarks combine to form a multitude of new particles, all moving in the same direction as the original quark, thereby forming a "jet." When a very high energy quark is ejected from a collision, a jet is what actually reaches the detector.

Seeing such jets is not new. They have become a standard feature of pp collisions at Fermilab. What is new is that the CDF data shows an unexpected excess of jets with energies above 200 GeV, an excess that cannot be ex-

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plained by the best theoretical models. Analysis of such data is tricky, because a background from non-jets must be subtracted, and any misestimation of background could lead to effects like the one reported. Thus, delicate judgment calls within the CDF group were involved in analyzing the data and deciding to report the results. We would prefer confirmations from other experiments, but for the moment let's accept the result as reported. One interpretation of the surplus of jets with too much energy is that deep within quarks are even smaller particles with even larger masses which have collided. Thus, the CDF work suggests that there are particles more fundamental than quarks.

This would be the next link in a chain of similar discoveries. In 1911 Ernest Rutherford, after his group at Manchester observed alpha particles scattered from a thin sheet of gold sometimes emerging at very large angles, concluded that atoms must have a heavy compact substructure which we now call the atomic nucleus. In 1990 Taylor and Kendall won the Nobel prize for the discovery, made by their group working at SLAC in the 1970s, that electrons scattered from protons show substructure within the proton. Their work supplied the convincing experimental confirmation of the quark model. Now quark-quark scattering by the CDF group shows evidence for substructure within the quark itself.

The CDF work suggests that there are new and previously unknown particles from which quarks (and perhaps also electrons and neutrinos, i.e., leptons) are made, just as protons and neutrons are made of quarks, as nuclei are made of neutrons and protons, as atoms are made of nuclei and electrons, as molecules are made of atoms, as cells are made of molecules, and as we are made of cells. Is this hierarchy of wheels-within-wheels infinite, or does it stop somewhere?

There's a story attributed to Freeman Dyson in which a physicist encountered a man who devoutly believed that the Earth is flat. The physicist was intrigued and asked what holds the Earth up. The man answered with great conviction that the Earth is a large flat disk supported on the back of a giant turtle. The physicist laughed and suggested that perhaps the turtle was in turn held up by an elephant or a dragon. "Oh no," the man whispered conspiratorially, "it's turtles, all the way down!" So the question is, has CDF turned up evidence for the fundamental ground structure of matter? Or have they simply reached the next layer of turtles?

If the CDF discovery of quark substructure is confirmed by further experiments, it will not have not caught theoretical physicists by surprise. The territory of quark sub-structure is already provisionally mapped, starting some 22 years ago when Salam and Pati proposed the first explicit model of quark substructure. They suggested that the quark is composed of pre-quarks which they called "preons."

There are now a number of preon models, all attempting to explain the properties of quarks and leptons (electrons and neutrinos). These are:

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(1) quarks and leptons have three "generations" (e.g., up, charmed, and top) with escalating mass scales, (2) each generation has two "flavors" (e.g., up or down) with differing electric charges, and (3) within each flavor/generation the quark member has one of three strong-force "colors" while the lepton member is "colorless." In addition, each quark or lepton has an antimatter counterpart with opposite charge and color, each has an intrinsic spin of 1/2 an $\hbar$ unit of angular momentum ($\hbar$ = Planck's constant divided by 2π = 197 MeV/c x 10^{-15} m), and each has a "parity" (positive or negative) describing its behavior under space-reversal (change the coordinate x to -x, etc.). Matter quarks and leptons have positive parity, meaning that their wave functions do not change sign after space reversal. Curiously, the anti-matter quarks have negative parity, meaning that their wave functions do change sign. The masses of the quarks and leptons span a very large range with the lightest lepton (the e-neutrino) having a mass close to zero, and the heaviest quark (the top) having a mass of about 180 GeV. If we consider quarks with different colors to be different particles then there are altogether 24 quarks and leptons plus 24 antimatter counterparts to explain.

Most preon models describe each quark and lepton as a combination of three preons. In the preon model of Salam and Pati a quark or lepton contains one of three "somons" that determines its generation, one of two "flavons" that determines its flavor and electrical charge, and one of four "chromons" that determines its color (or lack thereof) and modifies its electrical charge. Somons are electrically neutral and colorless. Flavons have electric charges of either +1/2 or -1/2 of a proton charge and are colorless. Chromons that are red, green, or blue have a charge of +1/6, while the colorless chromon has a charge of -1/2. The possible combination of 3 x 2 x 4 preons gives all 24 quarks and leptons with appropriate generations, colors, and charges. The preon model makes no attempt to explain the quark masses except to suggest that the higher generation somons are heavier, while the colorless flavon is particularly light.

The preon model offers the bargain of "explaining" 24 particles as combinations of 9 preons, which can be viewed as not much of an economy. A more economic variation of the preon model is the rishon model of Harari and Seidberg, which describes all 16 of the particles and antiparticles in a particular generation as 3-particle combinations of "rishons." There are two rishon types, each type having three possible colors and hypercolors, with generations as excited states of the 3-rishon system, so that the rishon model uses only 2 preons and their antimatter counterparts to generate the 48 quarks and leptons.

The show-stopper problem of all preon models of quark substructure is mass-energy. A composite particle may be either lighter or heavier than the sum of its components at rest. A nucleus (size about 10^{-13} m) is slightly lighter than the neutrons and protons from which it is made due to the

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strong-force binding energy that holds the nucleus together. It "costs" about 8 MeV of energy to pull each neutron or proton loose from its nuclear binding, so an assembled nucleus has about 1% less mass-energy than its disassembled components.

On the other hand, the proton (size about 10^{-15} m) is much heavier than the combined masses of its three components (two up quarks and one down quark). The proton's mass in energy units is 938 MeV, while the up quark has a mass of only about 4 MeV and the down quark about 7 MeV. The majority of the proton's mass comes from the kinetic energy of its quark components. Within a proton the quarks are confined to a "box" only 10^{-15} m across. Heisenberg's uncertainty principle dictates that the product of uncertainties in position and momentum must be greater than $\hbar$, so a quark localized to 10^{-15} m must have a momentum uncertainty of at least 197 MeV in energy units. The energy contributions from three quarks having about this momentum in each of three space directions approximately equals the proton mass, which thus derives mainly from the internal motions of its constituent quarks, not from their rest masses.

We know from scattering experiments that quarks and leptons are "pointlike" down to distance scales of less than 10^{-18} m (or 1/1000 of a proton diameter). The momentum uncertainty of a preon (of whatever mass) confined to a box of this size is about 200 GeV, 50,000 times larger than the rest mass of an up-quark and 400,000 times larger than the rest mass of an electron. Thus, the preon model presents a mass paradox.

One way in which the huge mass from internal momentum can be "nulled out" is to postulate a new and extremely strong force (or hyperforce) which would tightly bind preons inside a quark or lepton. Such a hyperforce would have to be at least 1,000 times stronger than the strong interaction. It is also somewhat unwelcome because it would add considerable complication to the Standard Model, which already has too many arbitrary parameters (see my column in the 5/96 issue of *Analog*). With such a hyperforce acting, the preons would be so tightly bound inside a quark that the energy contribution from their large momentum would be canceled by the large binding energy. This approach has some appeal, but it has not been used successfully to explain the masses and other properties of quarks and leptons, particularly the large mass differences between generations and between quarks and neutrinos.

Since this is a science fiction magazine, it's amusing to speculate on an alternative approach which I propose here for the first time. Suppose we solve the mass paradox by giving preons a *tachyonic* rest mass. Tachyons (see my column in the 10/93 issue of *Analog*) are particles that have a rest mass that is imaginary (like the square root of -1) and if moving freely, travel with faster-than-light speeds. Bound tachyonic preons in a quark would not be of interest as faster-than-light particles, but would have a negative mass-squared that would subtract

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from and even cancel the large mass-energy contribution from the large momentum. By a suitable choice of tachyonic masses for preons and moderate binding forces, the observed masses of quarks and leptons should be accommodated. Moreover, tachyonic mass that did not quite cancel for the lightest particles would even explain recently published experimental evidence (not taken seriously in the physics community) that the electron neutrino is tachyonic, with a mass-squared of $-130 \pm 20\ eV^2$ (see ref).

In any case, this is a new and exciting time for high energy physics. The well tested QCD Standard Model of particle physics shows signs of being broken and in need of closer examination by new experiments and of repair by theorists. Yesterday's fundamental particle, the quark, may be a composite object assembled from even more fundamental preons. And who knows what particles preons are made of? I'm reminded of a modern poem, derived from Swift, that my late father was fond of quoting: "Great fleas have lesser fleas, upon their backs to bite 'em, and the smaller one have smaller ones, and so on, ad infinitum. . . ." ■

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A glass may be half full or half empty; but either way, half a glass is better than none.

—Kelvin Throop III

Some people see the glass as half-full. Others see it as half-empty. I see it as too big.

—George Carlin

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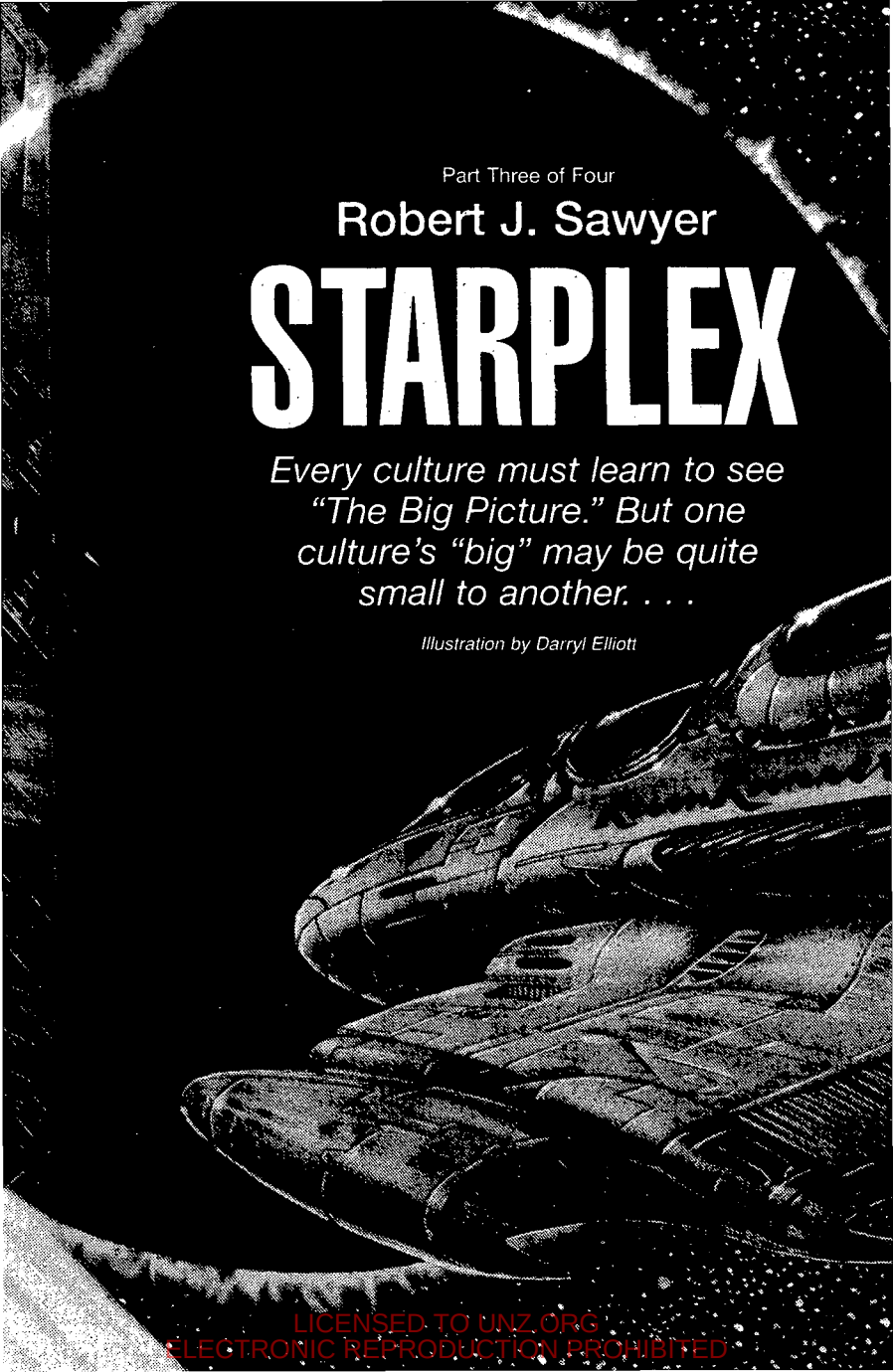
Part Three of Four

Robert J. Sawyer

STARPLEX

Every culture must learn to see "The Big Picture." But one culture's "big" may be quite small to another. . . .

Illustration by Darryl Elliott



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Synopsis

The giant starship Starplex *is severely damaged, and hundreds of Commonwealth citizens are dead.* **Keith Lansing,** Starplex*'s director, is in a small travel pod, heading away from* Starplex*. He approaches a shortcut—one of four billion artificial and apparently abandoned stargates that permeate the Milky Way Galaxy—selecting the appropriate entrance angle to exit at New Beijing (the Earth colony world of Tau Ceti IV).*

But instead of emerging at his intended destination, Keith arrives near a rose-colored nebula. A starship from some vastly advanced culture, shaped roughly like a dragon, approaches Keith's pod and draws it into a cavernous docking bay. Keith had *correctly selected for Tau Ceti, but he's been diverted—by someone who can control the stargates. Keith realizes he's about to meet the never-before-seen makers of the shortcut network.*

The bay's interior is transformed into a simulation of Earth's countryside. A transparent humanoid figure, whom Keith dubs **Glass,** *appears. He says Keith holds the key not just to the future, but also the past. The humanoid is inordinately interested in Keith's family: his wife,* **Clarissa "Rissa" Cervantes,** *who serves as* Starplex*'s head of life sciences, and their son Saul, now off at university. But soon Glass is called away, and Keith is left to explore the Earth simulation. He notes that some of the details are wrong: all the clover is four-leafed, and although he recognizes many of the plant and animal species, he also sees an emerald songbird that's completely unfamiliar. Keith is left puzzling this over, while we learn the story of how he got to this point. . . .*

The year is 2094. Eighteen years earlier, the shortcut network was discovered. Shortly thereafter, humans and dolphins joined with two alien races to form the Commonwealth of Planets. The alien races are the Ibs (wheeled, gestalt creatures from the planet Flatland, 53,000 light-years from Earth) and the Waldahudin (six-limbed, piglike creatures from the planet Rehbollo, 70,000 light-years from Earth).

A shortcut is inactive until something enters it locally. When a new shortcut comes online, the giant Commonwealth research vessel Starplex *is dispatched to investigate. But when* Starplex *emerges at the most recently activated exit point, the crew is amazed to see* twinkling *stars in open space.*

Of course, it turns out that the stars aren't really twinkling. Rather, they're being obscured by clouds of dust and hundreds of giant Jupiter-sized spheres. The spheres seem packed much closer together than their gravity would normally allow.

Automated probes are sent into one of the spheres, and samples are brought on-board. The material is bizarre indeed: it has no electrical charge whatsoever, it can pass through regular matter, and, in addition to its long-range gravitational force, it also possesses a short-range

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repulsive force. **Jag,** *the Waldahud who serves as* Starplex*'s head of physical sciences, is the first to realize that the material is* dark matter. *Dark matter makes up the vast bulk of the mass of the Universe; its gravitational effects are detectable, but its actual nature has never been determined.*

Other research is going on simultaneously aboard Starplex. *Rissa and an Ib named* **Boxcar** *are undertaking experiments in life prolongation, although so far they've had no luck. Rissa confides to Boxcar that she's concerned that her husband Keith is contemplating an affair with another woman, possibly* **Lianne Karendaughter,** Starplex*'s internal-operations manager. Meanwhile, Keith finds himself fighting with Jag. Jag is one of five males competing for a specific female; he is determined to find glory enough to win her, no matter what.*

Suddenly the shortcut nearest Starplex *starts to open up. What appears to be a starship fusion exhaust is blasting through the aperture, as if a vessel had been braking when it entered the stargate. But the aperture keeps growing larger and larger, and the fusion exhaust is green. A tongue of plasma shoots out toward* Starplex. *As the shortcut continues to swell in size, Jag realizes that the object emerging from it isn't a spaceship—it's a star!*

Starplex *is bombarded with radiation from the star. Keith turns the ship so that its lower decks face the shortcut, and everyone is evacuated to above the central ocean deck; the water in it provides shielding from the radiation until the ship reaches a safe distance.*

Jag and a dolphin named **Longbottle** *do a flyby of the star in a heavily shielded probeship. Jag is perplexed by what he finds: a star with so much metal content simply should not exist in a Universe as young as ours.*

A communications buoy pops out of the shortcut with staggering news: stars have also emerged from the shortcuts nearest Tau Ceti and Rehbollo—and the phenomenon may be even more widespread than that.

At first, the Starplex *crew thinks the erupting stars might represent an attack on the Commonwealth worlds. But soon another star—also green—is detected having recently come out of an* inactive *shortcut nowhere near any habitation. Incredibly, it seems as though stars may be emerging through all four billion shortcuts throughout the Milky Way.*

Jag was willing to consider one green metal-rich star a freak, but the best explanation he can come up with for multiple ones is that they are fourth-generation *stars arriving from billions of years in the future. The shortcuts don't just allow travel in space; they also serve as portals back into time.*

But why would stars be sent into the past? A logical question—and the logical person to ask for the answer is someone in the far future. Jag constructs a cube that will last for many billions of years, with a symbolic question etched into its sur-

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face: "Shortcut with star emerging from it equals what?" The cube, which has starlight-powered positioning jets, is released from Starplex *near the shortcut, in hopes that beings from the future will stumble across it and send an answer back to the past.*

Meanwhile, tempers continue to flare aboard Starplex. *The humans and Waldahudin seem incapable of getting along.* Starplex *takes a quick trip to Flatland to replace its irradiated lower habitat modules. And Rissa is stunned when Boxcar announces that she's going to kill herself soon, as punishment for a minor crime committed in her youth.*

It's discovered that the dark-matter spheres are giving off weak radio signals—and the signals are complex enough to possibly represent a language. As the crew watches, amazed, one of the dark-matter spheres splits into two. The spheres are giant living creatures, which the crew decides to call "darmats." Attempts are made to communicate with them via radio, establishing a dialog with the darmat leader, **Cat's Eye.**

The shortcut nearest Starplex *opens again—and the cube Jag built pops out. A message carved into it says, "Pushing back the stars is necessary, and not a threat. It will benefit us all. Don't be afraid." Incredibly, the message is signed "Keith Lansing," and is apparently dated the year 10,646,397,281 A.D. Rissa realizes that her life-prolongation experiments are going to succeed beyond her wildest dreams. . . .*

* * *

PART 3
Zeta Draconis

Glass rose from the clover-covered ground. "Perhaps you need some time to rest," he said. "I'll be back in a little while."

"Wait," said Keith. "I want to know who you are. Who you really *are."*

Glass said nothing, his head inclined to one side.

Keith got to his feet as well. "I've got a right to know. I've answered every one of your questions. Now, please, answer this one of mine."

"Very well, Keith." Glass spread his arms. "I'm you—Gilbert Keith Lansing—but you of the future. You don't know how long I'd been racking my brain trying to remember what the bloody 'G' stood for."

Keith's jaw had dropped. "That—that can't be right. You can't be me."

"Oh, yes I am," said Glass. "Of course, I'm a little bit older." He touched the side of his smooth, transparent head, then made the windchime laughter sound. "See? I've lost all my hair."

Keith narrowed his eyes. "How far in the future are you from?"

"Well," said Glass, gently, "actually, you've got it backward. We are in my *present. The appropriate question is, how far from the past are you from?"*

Keith felt himself losing his balance. "You mean—you mean this isn't 2094?"

"Twenty-ninety-four what?"

"The Earth year 2094—2094 A.D. Two thousand and ninety-four years after the birth of Christ."

"Who? Oh, wait—my reckoner just

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reminded me. Let me work it out; I know the current year in absolute counting from the creation of the Universe, but . . . ah, OK. In your system, this is the year ten billion, six hundred and forty six million, three hundred and ninety-seven thousand, two hundred and eighty-one."

Keith staggered back a half pace. "You sent back our time capsule."

"That's right."

"How—how did I get here?"

"When your pod passed through the shortcut, I locked you into stasis. Time passed in the Universe, but not for you. When it got to be this year, I unlocked you. Don't worry, though. I intend to put you back where you came from." A pause. "Remember that pink nebula you saw as you came out of the gate? That's what's left of what used to be Sol."

Keith's eyes went wide.

"Don't be concerned," said Glass. "No one was injured when Sol went nova. It was all carefully engineered. See, that type of star doesn't naturally go nova; it just decays to a white dwarf. But we like to recycle. We blew it up so that its metals would enrich the interstellar medium."

Keith felt dizzy. "And how—how are you going to return me to my time?"

"Through the shortcut, of course. Time travel to the past works well; we just can't do it to the future—that's why we had to let you come forward in stasis through ten billion years. Ironically, it turns out that it's forward time travel, not backward travel, that results in unsolvable paradoxes, making it impossible. We'll send you back to the moment you left. You don't have to worry about your friends missing you; no matter how many hours you generously stay with us, we'll get you to Tau Ceti at the time you're expected."

"This is incredible."

Glass shrugged. "It's science."

"It's magic," said Keith.

Glass shrugged again. "Same thing."

"But—but—if you're really me, if you're really from Earth, then why did you screw up on the simulation?"

"Pardon?"

"The Earth simulation. It has errors in it. Fields full of four-leaf clover, something only ever found as the occasional mutant, and birds that I've never seen before."

"Oh." The wind-chime sound. "My mistake. I took the simulation from some ancient recordings we had, but I was probably a bit sloppy. Let me just check with my reckoner . . . yup, my fault. It is a perfect simulation of Earth, but of Earth about 1.2 million years after you were born. The things that were out of place were species that hadn't yet evolved in your time. Come to think of it, you wouldn't have recognized the constellations, either, if I'd ever let it become nighttime."

"My God," said Keith. "I hadn't even begun to think about evolution. If you're ten billion years older than me, then—then you're older than any form of life on Earth in my time."

Glass nodded. "By your time, life had been evolving on Earth for four

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billion years. But there are Earth-descended lifeforms in this time that are products of fourteen billion years of evolution. You'll never believe what daisies evolved into—or sea anemones, or the bacteria that caused whooping cough. In fact, I had lunch a few days ago with someone who evolved from whooping-cough bacteria."

"You're kidding."

"No, I'm not."

"But it's incredible. . . ."

"No. It's just time. Lots and lots of time."

"What about humans? Did humans continue to breed, to have children? Or did that stop when—when life-prolongation was discovered?"

"No, humanity continues to evolve and change. New humans—those who've been evolving for the last ten billion years—don't mix much with old humans like me. They're . . . quite different."

"But if you're me, how did you change? I mean, your body is see-through."

Glass shrugged. "Technology. Flesh and blood tends to wear out; this is better. In fact, I can reconfigure myself any way I want. Transparent is in style right now, but I think the hint of aquamarine is quite classy, don't you?"

CHAPTER 16

Rissa, Hek, and the rest of the alien-communications team continued to exchange messages with the darmat they'd dubbed Cat's Eye. The conversation become increasingly fluid as new words were added to the translation database, or old words had their meanings refined. When Keith next came onto the bridge, Rissa was in the middle of an apparently philosophic conversation with the giant being. The usual alpha-shift crew was on duty, except that the ExOps station was vacant: Rhombus was off doing something else, and his position had been slaved to a dolphin floating in the open pool on the starboard side of the bridge.

"We have been unaware of your existence," Rissa said into the microphone stalk rising from her console. "We knew a large amount of invisible matter was out there, because of the gravitational effects, but we didn't know it was alive."

"Two types of substance," replied the darmat in that French accent PHANTOM had assigned to him.

"Yes," said Rissa. She looked up and waved a greeting at Keith as he took his seat next to her.

"Not react sharply," said the Cat's Eye. "Only gravity the same."

"That's correct," said Rissa. The all-encompassing hologram showed an enhanced view of Cat's Eye in front of the cluster of workstations.

"Most like us," said the darmat.

"The vast majority of all matter is like you, yes," replied Rissa.

"Ignore you."

"You've ignored us?"

"Insignificant."

"Were you aware that part of our type of substance was alive?"

"No. Not occur to look for life *on* planets. So small you are."

"We wish to have a relationship with you," said Rissa.

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"Relationship?"

"For mutual benefit. One plus one equals two. You plus us equals more than two."

"Understand. More than the sum of the parts."

Rissa smiled. "Exactly."

"Relationship sensible."

"Do you have a word for those with whom you have mutually beneficial relationships?"

"Friends," said the darmat, PHANTOM translating the word the first time it had been received. "We call them friends."

"We are friends," said Rissa.

"Yes."

"The kind of material you're made out of—the material we call dark matter—is all of it alive?"

"No. Only tiny fraction."

"But you say there has been living dark matter for a very long time?"

"Since the beginning."

"Beginning of what?"

"Of—all the stars combined."

"Of the totality of everything? We call that the Universe."

"Since the beginning of the Universe."

"That's an interesting point right there," said Jag, sitting on Keith's left. "The idea that the Universe had a beginning—it did, of course, but how does it know that? Ask it about that."

"What was the Universe like in the beginning?" said Rissa into the mike.

"Compressed," said the darmat. "Small beyond small. One place, no time."

"The primordial atom," said Jag. "Fascinating. It's right, but I wonder how such a creature would deduce that?"

"They communicate by radio," said Lianne, turning around at InOps to face Jag. "They probably reasoned it out the same way we did: from the cosmic microwave background and the redshifting of radio noise from distant galaxies."

Jag grunted.

Rissa continued her dialog: "You have told us that neither you personally, Cat's Eye, nor this group of darmats, is anywhere near that old. How do you know that darmat life existed all the way back to the beginning?"

"Had to," replied the darmat.

Jag barked dismissively. "Philosophy," he said. "Not science. They just want to believe that."

"We have not existed nearly that long," said Rissa into the microphone stalk. "We have not found any evidence for life of any type made out of our kind of matter that is more than four billion years old." PHANTOM converted the time expression into something the darmat could understand.

"As said earlier, you are insignificant."

Jag barked at PHANTOM. "Query: how was the translation for 'insignificant' derived?"

"Mathematically," said the computer in the appropriate language into each individual's earpiece. "We established that the difference between 3.7 and 4.0 was 'significant,' but that the difference between 3.99 and 4.00 was 'insignificant.'"

Jag looked at Rissa. "So in this context the word might convey a different sense. It might mean something metaphorical—a 'late arrival' could be

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equated with insignificance, for instance."

Thor looked over his shoulder at the Waldahud and grinned. "Don't like the idea of being dismissed out of hand, eh?"

"Don't be abrasive, human. It's simply that we have to be careful when generalizing the use of alien words. And besides, perhaps he's referring to the signaling probe. At less than five meters in length, it could indeed be termed insignificant."

Rissa nodded and spoke into the mike. "When you say we are insignificant, are you referring to our size?"

"Not size of speaking part. Not size of part that ejected speaking part."

"So much for outsmarting him," said Thor, grinning. "He knows that the signaling probe came from this ship."

Rissa covered the mike with her hand; the gesture was as good a signal as any to PHANTOM to temporarily halt transmission. "It doesn't matter, I guess." She removed her hand and spoke again to Cat's Eye. "Are we insignificant because we haven't been around as long as you have?"

"Not a question of time length; a question of time absolute. We here from beginning; you not. By definition, we significant, you not. Obviously so."

"I don't know about that," said Keith, good-naturedly. "The good guys are never first, only better."

Rissa covered the mike and looked at him. "Regardless, I think we should steer clear of philosophy until we're more comfortable with each other. I don't want to accidentally give offense and cause him to clam up."

Keith nodded.

Rissa spoke into the mike again. "Presumably there are other communities of darmats."

"Billions of communities."

"Do you interact with them?"

"Yes."

"Your radio signals are not powerful, and are close to the frequency of the microwave background radiation. They would not be perceptible over a great distance."

"True."

"Then how do you interact with other darmat communities?"

"Radio-one only for local talk. Radio-two for communication between communities."

Lianne turned to Rissa. "Is he saying what I think he's saying? That the darmats are natural transmitters of hyperspace radio?"

"Let's find out," said Rissa. She faced the mike again. "Radio-one travels at the same speed as light, correct?"

"Yes."

"Radio-two travels faster than light, correct?"

"Yes."

"Jesus," said Keith. "If they use hyperspace radio, how come we've never encountered their signals before?"

"There are an infinite number of quantized hyperspace levels," said Lianne. "None of the Commonwealth races has had hyperspace radio for more than fifty years, and the whole Commonwealth uses only about eight thousand quantized levels; it's quite possible that we've never happened to key into one of the ones the dar-

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mats use." She turned her gaze to Rissa. "The way we do hyperspace radio requires an enormous amount of energy. It would be well worth pursuing this topic. They may have a method of doing it that takes a lot less power."

Rissa nodded. "We use a kind of radio-two, as well. Will you tell us more about how yours works?"

"Tell all," replied Cat's Eye. "But little to tell. We think one way, thought is private. We think another way, thought is transmitted on radio-one. We think a third, harder way, and thought is transmitted on radio-two."

Keith laughed. "It's like asking a human to explain how speech works. We just do it, that's all. It's—"

"Forgive me for interrupting, Dr. Lansing," said PHANTOM, "but you asked me to remind you and Dr. Cervantes of your 14:00 appointment."

Keith's face fell.

"Damn," he said. "Damn." He turned to Rissa. "It's time."

She nodded. "PHANTOM, please get Hek down here to continue the dialog with Cat's Eye."

As soon as Hek had arrived, they both rose from their chairs and left the room.

Keith and Rissa exited from the elevator and walked the short distance to the oversized black door with the giant fluorescent orange 20 painted on it. The locking bolts pulled aside. The noise they made had always been faintly familiar to Keith, but this time he finally placed it: it was just like the sound of a rifle being cocked in an old-time Western movie.

Most doors aboard ship split down the middle with the two panels moving into pockets on either side, but this heavy one slid as one piece to the left—safety demanded there be no seams or weak points in the seal.

Rissa gasped. Keith felt his jaw go slack.

There were well over a hundred lbs in the docking bay, lined up in neat rows—like a parking lot filled with wheelchairs. "PHANTOM, how many are there?" Keith said softly.

"Two hundred and nine, sir," replied the computer. "The entire ship's complement of Integrated Bioentities."

Rissa shook her head slightly. "She said only her closest friends would attend."

"Well," said Keith, stepping into the room, "Boxcar is very personable. I guess all the lbs aboard consider her a close friend."

There were six other humans present, all members of Rissa's Life Sciences staff. There was also one lone Waldahud, whom Keith couldn't quite place. Keith glanced at his watch: 13:59:47. No doubt whatever was going to happen would begin on time.

"Thank you all for coming," said Boxcar's voice, over Keith's implant. It was easy to spot her: hers was the only web flashing. It was eerie, in a way. PHANTOM's translation was piped into his left acoustic nerve; the other ear heard nothing—even a room this size, full of raucous lbs, could be dead silent.

Boxcar was fifteen meters from where Keith and Rissa were standing. In front of the plated space door,

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PHANTOM was projecting a giant hologram of Boxcar, so that all the Ibs could see her flashing web. Something strange, there: the strands of her web were bright green. Keith had never seen any Ib's web that color before.

He turned to Rissa, but she must have guessed his question. "It represents a deeply emotional state," she said. "Boxcar is choked up over the show of support from her people."

Boxcar's web flashed again. The translation said, "The whole and the parts—of one, and of them all. The gestalt has resonances on the macro scale and the micro. It binds."

Obviously, Boxcar was addressing her fellow Ibs. Keith thought he got the gist of what she was saying—something about being part of the Ib community having meant as much to her as being a community of parts herself. Keith prided himself on his acceptance of aliens, his run-ins with Jag notwithstanding. But this was all a little too surreal for him; he knew he was about to watch someone die, but the emotions he should be feeling hadn't yet come to the surface. Rissa, on the other hand, had that look she got when trying not to cry. She and Boxcar had been closer than he'd known, Keith realized.

"The road is clear," concluded Boxcar. She rolled several dozen meters away from the others, out into the center of the bay.

"Why's she doing that?" whispered Keith.

Rissa shrugged her shoulders, but PHANTOM replied into both of their implants: "During discorporation, components—especially wheels—may panic, and seek to bond with any other Ib in the area. It is customary to move far enough away so that if such a thing is attempted, there's plenty of time to react."

Keith nodded slightly.

And then it began. In the middle of the bay was a standard Ib comfort mound. Boxcar rolled over it, so that the hump supported her frame from underneath. Her web—visible in PHANTOM's giant hologram—turned an almost electric purple, another color Keith had never seen before. The light points at the web's countless intersections grew brighter and brighter, a dense constellation map with every star a nova. Then, one by one, the lights winked out. It took perhaps two minutes for them all to go dark.

Boxcar's frame tipped forward, and her web slid off to the bay floor, landing in a loose pile. Keith had thought the web was already dead, but it arched up sharply, as if a fist were pushing it up from underneath. The strands had now lost all their color; they looked like thick nylon fishing line.

After a moment, though, the web finally did expire, collapsing into a heap. Boxcar was now blind and deaf (she had once had a magnetic sense, too, but that had been neutralized through nanosurgery when she'd left her homeworld; it caused severe disorientation aboard spaceships).

Next, Boxcar's wheels disengaged from the axles on the frame. Wheel disengaging wasn't unusual in and of itself. The system that allowed nutrients to pass from the axle into each

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wheel didn't provide enough food for the wheels, and in their native environment they would periodically separate from the rest of the gestalt for feeding. Thick tendrils, similar to the Ib's bundle of manipulatory ropes, popped out of the sides of the wheels, preventing them from falling over (or righting them if they did).

Almost immediately after it separated, the left wheel tried to rejoin the frame. Just as PHANTOM said it might, it panicked when it realized that little bumps had risen up all around the axle's circumference, preventing it from reconnecting. It rolled around the bay, the grabbing projections around its rim extending and retracting at a great rate. The wheel had a few vision sensors of its own, and as soon as it caught sight of the huge collection of Ibs, it made a beeline for the closest. That Ib spun away, avoiding the wheel. One of the others—Butterfly, Keith assumed, the one Ib doctor on board—surged forward, a manipulatory rope extended, a silver-and-black medical stunner held at its tip. The stunner touched the wheel, and it stopped moving. It stood for several seconds, then the root-like appendages coming out of its sides seemed to go soft, and the wheel toppled onto its side.

Keith turned his attention back to the center of the bay. Boxcar's bundle of ropes had slid to the floor, near the discarded sensor web. They were reaching up to the frame and disengaging the blue pump from the central green pod, and gently lifting the pump to the floor. Keith could see the pump's large central breathing orifice cycling through its usual four-step sequence of open, stretch, compress, and close. After about forty seconds, though, the sequence started to get distorted as the pump seemed to lose track of what it was doing. The orifice movements became jumbled—opening, then immediately compressing; trying to stretch wide after closing. There was a small gasping sound—the only sound in the entire bay. Finally the pump stopped moving.

All that was left was the pod, sitting on the saddle-shaped frame.

Keith whispered to Rissa: "How long can the pod survive without the pump?"

Rissa turned to him, her eyes wet. She blinked several times, dislodging tears. "A minute," she said at last. "Perhaps two."

Keith reached over and squeezed her hand.

Everything was still for about three minutes. The pod expired quietly, without movement or sound—although somehow, apparently, the Ibs knew when it was gone, and, as one, they began to roll out of the bay. All their webs were dark; not a word was passing between them. Keith and Rissa were the last to leave. Butterfly would return shortly, Keith knew, to take care of jettisoning Boxcar's remains into space.

As they walked out of the bay, Keith thought about his own future. He was going to live a long, long time, apparently. He wondered whether billions of years from now he'd be able to escape the mistakes of his own past.

They couldn't sleep that night, of

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course. Boxcar's death had upset Rissa, and Keith was wrestling with his own demons. They lay side by side in their bed, wide awake, Rissa staring at the dark ceiling, Keith looking at the faint red spot on the wall made by the light seeping around the plasticard he used to cover his clock face.

Rissa spoke—just one word. "If. . . ."

Keith rolled onto his back. "Pardon?"

She was quiet for a time. Keith was about to prod her again, when she said, very softly, "If you don't remember how to make a U or an apostrophe, will you remember me—remember us?" She rolled over, looked at him. "You're going to live another ten billion years. I can't begin to comprehend that."

"It's . . . mind-numbing," said Keith, shaking his head against the pillow. He, too, was quiet for a time. Then: "People always fantasize about living forever. Somehow, 'forever' seems less daunting than putting a specific date on it. I could deal with immortality, but contemplating the specific notion of being alive ten billion years from now . . . I just can't make sense of it."

"Ten billion years," said Rissa again, shaking her head. "Earth's Sun will long be dead, Earth will be dead." A beat. "I will be dead."

"Maybe. Maybe not. If it *is* life prolongation, then surely it's because of your studies here on *Starplex*. After all, why else would I have ended up as one of the recipients of the process? Maybe we're both alive ten billion years from now."

More silence.

"And together?" said Rissa, at last.

Keith exhaled noisily. "I don't know. I can't imagine any of it." He sensed he was saying the wrong thing. "But . . . but if I'm to face that much of a future, I would want it to be with you."

"Would you?" said Rissa, at once. "Would we have anything left to explore, to learn about each other, after all that time?"

"Maybe . . . maybe it's not corporeal existence," said Keith. "Maybe my consciousness is transferred into a machine. Wasn't there a cult on New New York that wanted to do that—copy human brains into computers? Or maybe . . . maybe all of humanity becomes one giant mind, but the individual psyches can still be tapped. That would be. . . ."

"Would be less frightening that the concept of personally living another ten billion years. In case you haven't done the math yet, that would mean that so far, you've only lived one two-hundred-millionth of the age you're going to become." She paused and sighed.

"What?" asked Keith.

"Nothing."

"No, you're upset about something."

Rissa was quiet for about ten seconds. "Well, it's just that your current mid-life crisis has been hard enough to live with. I'd hate to see what kind of stunts you're going to pull when you turn five billion."

Keith didn't know what to say. Finally, he settled on a laugh. It sounded hollow to him, forced.

Quiet again—long enough that he

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thought perhaps she'd at last fallen asleep. But he couldn't sleep himself. Not yet, not with these thoughts going through his head.

"Dulcinea?" he whispered softly—so softly that if she were already asleep he hopefully wouldn't wake her.

"Hmm?"

Keith swallowed. Maybe he should leave the issue alone, but . . . "Our anniversary is coming up."

"Next week," said the voice in the darkness.

"Yes," said Keith. "It'll be twenty years, and—"

"Twenty *wonderful* years, honey. You're always supposed to include the adjective."

Another forced laugh. "Sorry, you're right. Twenty wonderful years." He paused. "I know that we're planning to renew our wedding vows that day."

A small edge to Rissa's voice. "Yes?"

"Nothing. No, forget I said anything. It *has* been a wonderful twenty years, hasn't it?"

Keith could just make out her face in the darkness. She nodded, then looked at him, meeting his eyes, trying to see beyond them, see the truth, see what was bothering him. And then it came to her, and she rolled onto her side, facing away from him. "It's OK," she said at last.

"What is?"

And she spoke the final words that passed between them that night. "It's OK," she said, "if you don't want to say, 'for as long as we both shall live.'"

Keith sat at his workstation on the bridge. Holograms of three humans and a dolphin hovered above the station's rim. In his peripheral vision, he was aware of one of the bridge doors opening and Jag waddling in. The Waldahud didn't go to his own workstation, though. Instead he stood in front of Keith's and waited, in what seemed a state of some agitation, while Keith finished the conference he was conducting with the holographic heads. When they'd logged off, Keith looked up at Jag.

"As you know, the darmats have been moving," said Jag. "I'm frankly surprised at their agility. They seem to work together, each sphere playing off its own gravitational and repulsive forces against the others to move the whole community cooperatively. Anyway, in doing so, they've completely reconfigured themselves, so that individual darmats that we couldn't clearly observe before are now at the periphery of the assemblage. I've made some predictions about which darmat might next reproduce, and I'd like to test my theory. For that, I want you to move *Starplex* to the far side of the dark-matter field."

"PHANTOM, schematic local space," said Keith.

A holographic representation appeared in midair between Keith and Jag. The darmats had moved around to the opposite side of the green star, so that *Starplex,* the shortcut, the star, and the darmat community were pretty much arranged in a straight line.

"If we move to the far side of the darmat field, we'll be out of view of the shortcut," said Keith. "We might miss seeing a watson come through.

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Can't you just put a probe there?"

"My prediction is based on very minute mass concentrations. I need to use either our deck-one or deck-seventy hyperscope to make my observations."

Keith considered. "All right." He tapped a key on his console and the usual holograms of Thor and Rhombus popped into being. "Rhombus, please check with everyone who is currently doing external scanning. Find out when the soonest we can move the ship without interrupting their work will be. Thor, at that time take us to the opposite side of the dark-matter field, positioning us at coordinates Jag will supply you with."

"Serving is the greatest pleasure," said Rhombus.

"Bob's your uncle," said Thor.

Jag moved his head up and down, imitating the human gesture. Waldahudin never said "thank you," but Keith thought the pig looked inordinately pleased.

CHAPTER 17

The bridge was calm, the six workstations floating serenely against the holographic night. It was 0500 ship's time; delta shift was in the final hour of its watch.

In the director's position was an Ib named Wineglass; other Ibs were at the Internal-Ops and Helm stations. Physical Sciences was slaved to a dolphin named Melondent, a Waldahud was at life sciences, and a human named Denna Van Hausen was at External Ops.

A grid of force screens radiated down from the invisible ceiling, creating millimeter-wide vacuum gaps between each workstation, preventing transmission of noise between them. The Ib at Internal Ops was engaged in a holographic conference with three miniature floating Ibs and three disembodied Waldahud heads. The human at External was reading a novel on one of her monitor screens.

Suddenly, the silencing force fields snapped off and an alarm began to sound. "Unidentified ship approaching," announced PHANTOM.

"There!" said Van Hausen, pointing to the image of the nearby star. "It's just passing from behind the photosphere." PHANTOM was showing the unknown ship as a small red triangle; the actual vessel was far too small to be visible at this distance.

"Any chance that it's just a watson?" asked Wineglass, his British accent carrying a hint of Cockney.

"None," said Van Hausen. "It's at least as big as one of our probeships."

Lights moved across Wineglass's web. "Let's get a look at it," he said. The Ib at the helm station rotated the ship slightly so that the deck-seventy optical array was aimed at the intruder. A square frame appeared around part of the star, and within it a magnified view appeared. The approaching ship was illuminated on one side by the green star. The other side was a black silhouette, visible only because it eclipsed the background stars.

Wineglass spoke to Kreet, the Waldahud on his right. "That looks like a Waldahud design. The central engine pod, no?"

Waldahudin believed each ship—or building or vehicle—should be

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unique; they did not mass-produce from the same design. Kreet lifted all four of his shoulders. "Maybe," he said.

"Any transponder signal, Denna?" asked Wineglass.

"If there is one," the human said, "it's lost in the noise from the star."

"Please try to contact the ship."

"Transmitting," said Denna. "But they're still over fifty million klicks away; it'll take almost six minutes for any reply, and—God!"

A second ship was coming around the limb of the green star. It was similar in size to the first, but had a different, more blocky design. Still, the trademark Waldahud central engine pod was visible.

"Better get Keith down here," said Wineglass.

Lights rippled across the Ib at In-Ops. "Director Lansing to the bridge!"

"Try to contact the second ship, too," Wineglass said.

"Doing so," said Van Hausen. "And—Jesus, I'll try to contact that third one, as well." Another ship, half emerald fire glinting off polished metal, half black nothingness, was emerging from behind the star. A moment later a fourth and then a fifth appeared.

"It's a bloody armada," said Van Hausen.

"They Waldahud ships clearly are," said Melondent from his open pool to the left of the physics workstation. "Thruster exhaust signatures most characteristic."

"But what would five—six, *eight*—eight Waldahud craft want here?" asked Wineglass. "Denna, where are they heading?"

"They're doing parabolic paths around the star," the human woman said. "Hard to say exactly where they're planning to end up, but *Starplex*'s current position is within eight degrees of the most likely projected course."

"They after us are coming," said Melondent. "We should—"

A door appeared in the hologram. Keith Lansing strode onto the bridge, unshaven, hair matted down from sleep.

"Sorry to wake you early," said Wineglass, rolling away from the director's workstation, "but we have company."

Keith nodded at the Ib, and waited for a polychair to emerge from the trapdoor in front of his console. It was already morphing into human configuration as it rose up from the floor. Keith seated himself. "You've tried contacting them?"

"Yes," said Denna. "Earliest possible response is in forty-eight seconds, though."

"They're Waldahud ships, aren't they?" said Keith, his workstation rising to the height he preferred.

"Very likely so," said Wineglass, "although, of course, Waldahud ships are sold all over the Commonwealth. They could be crewed by somebody else."

Keith rubbed sleep from his eyes. "How did so many ships arrive without our knowing it?"

"They must have emerged one at a time from the shortcut while it was shielded from our view by the green star," Wineglass said.

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"Christ, of course," said Keith. He consulted the readout of who was operating which station. "Double-Dot, get Jag down here."

The Ib at Internal Ops slapped his control panel with ropes, then, a moment later, said, "Jag has his communications routed to a voice mailbox. It's his normal sleep period."

"Override," said Keith. "Get him down here right now. Denna, any reply to our messages?"

"Nothing."

Keith glanced up at the glowing digital clocks floating against the starfield. "It's almost shift change anyway," he said. "Let's get the full alpha-shift staff down here."

"Alpha shift, report immediately to the bridge," said Double-Dot. "Lianne Karendaughter, Thorald Magnor, Rhombus, Jag, and Clarissa Cervantes to the bridge, please."

"Thank you," said Keith. "Denna, open a channel to all the approaching ships."

"Open."

"This is G. K. Lansing, Director of the Commonwealth research vessel *Starplex*. State your business, please."

"Transmitting," said Denna. "They've closed the distance between us and them considerably. If they care to respond to your latest message, we should have an answer in under three minutes."

A door opened up in the part of the hologram displaying the framed close-up of the approaching craft. Jag walked through, his fur not yet brushed. "What's wrong?" he said.

"Maybe nothing," said Keith "but eight Waldahud ships are approaching *Starplex*. Do you know why?"

All four shoulders moved up and down. "I have no idea."

"They are refusing to respond to hails, and—"

"I said I have no idea." Jag turned around and faced the hologram where the door had been. All his eyes began tracking independently, each one watching a different approaching ship.

"What kind of ships are those?" asked Keith. "Scouts?"

"They are the right size for that," said Jag.

"How many crew members aboard each?"

"Starships are not my field," said Jag.

Keith looked at the Waldahud at life sciences. "You, there—Kreet, is it? How many people aboard such a ship?"

"Perhaps six," said Kreet. "No more than that."

Two of the four bridge doors opened simultaneously. Thorald Magnor walked in through one, and Rissa Cervantes came in through the other. The Ib and the Waldahud vacated the helm and life-sciences stations to make room for them.

"Eight ships are approaching *Starplex*," said Keith, to Rissa and Thor.

Rissa nodded. "PHANTOM briefed us *en route*. But no additional ships should have come through the short-cut until we gave the OK." She stood by her console, waiting for the chair to configure itself.

"Maybe they're here by accident," said Thor, tapping some keys on his

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console while his chair rose from beneath the deck. "When a new shortcut comes online, the acceptable approach angles to select a desired destination grow narrower. They could have been sloppy in their calculations. Maybe they meant to go somewhere else."

"One pilot might make a mistake," said Keith. "But eight?"

"The communications-lag time is up," said Denna. "If they'd wanted to reply to your latest message, they could have done so by now." Rhombus had entered a moment earlier, but was content to wheel up to a position next to the ExOps workstation without getting Denna to vacate.

"Thor, if I give the order to get out of here," asked Keith, "can we escape those ships?"

Thor shrugged. "I doubt it. They're blocking the shortcut, so we can't go that way. And see those medial rings around their engine pods? Those are associated with Waldahud *Gatob*-class hyperdrives. Of course, no one can use a hyperdrive this close to the green star, but if we tried to get away, eventually we would be out in space that was flat enough for hyperdrives to be engaged, and then they'd be on us in a second."

Keith frowned.

"The ships are fanning out," said Thor. "I'd call it an attack formation."

"Attack?" said Rhombus, lights strobing incredulously.

"Incoming message," said Denna.

Another part of the sky hologram was blocked off by a glowing border. Inside it a Waldahud face appeared, framed by brown fur streaked with copper. "Lansing commanding *Starplex*," said the translated voice, "I am Gawst. Mark that name well: Gawst." Keith nodded; to a Waldahud male, credit was everything. "We have come to escort *Starplex* back through the shortcut. You will surrender—"

"How long for a reply to reach them?" asked Keith.

"—Your ship to us."

Denna consulted a readout. "Forty-three seconds."

"Cooperate," continued Gawst, "and no harm will come to your vessel or crew."

"Thor, can we dive toward the shortcut apparently on one trajectory, but at the last moment change direction so that we'll exit somewhere other than where they'd expect?"

The helm officer shook his head. "Those little scouts might pull it off, but *Starplex*'s volume is three million cubic meters. I can't make it tap dance."

"How long until those ships reach us?"

"They're moving at .1*c*," said Thor. "They'll be on us in less than twenty minutes."

"Lansing to Gawst: *Starplex* is Commonwealth property. Request denied. Off. Rhombus, let me know when they've received that message." Lianne Karendaughter strode onto the bridge. "I want some options, folks," said Keith.

"Option number one," said Lianne, taking her seat. "Retreat. The farther we are from the shortcut, the less likely they will be able to coerce us through it."

"Right. Thor, let's—"

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"Forgive the interruption, Keith," said Rhombus. "Your message has been received."

"Good. Thor, let's get out of here. Full thruster power."

"I'll take us away at an angle," said Thor. "We don't want to move into the dark-matter field. It's an obstacle course, and small ships will be better able to handle it than we will."

"Fine," said Keith. "Rhombus, see if you can get a watson with today's mission logs through to Tau Ceti. I want to alert Premier Kenyatta."

"Doing so. But it will take over an hour to reach the shortcut from here, and—Excuse me: incoming message from Gawst."

"Lansing," said Gawst, "*Starplex* was built at the Rehbollo shipyards and is of Rehbollo registry, and therefore is Waldahud property. Let us avoid as much unpleasantness as possible. Once the ship is returned to Rehbollo, we will release all crew members for immediate repatriation to their home systems."

"Reply," snapped Lansing. "*Starplex*'s construction was funded by all the Commonwealth worlds, and its registration is just a formality; all ships require a homeworld of record. Your claim is rejected. If necessary, this ship will defend itself against unlawful seizure. Off."

"Defend itself?" said Thor, shaking his head. "Keith, this ship has no armament."

"I'm well aware of that," snapped Keith. "Lianne, give me a full inventory of all shipboard equipment that can be used as weapons. If anything aboard can discharge an energy beam, or throw an object, or can be made to blow up, I want to know about it."

"Working on it," said Lianne, hands dancing over her console.

"*Starplex* wasn't designed for fancy flying," said Thor, speaking to a Keith hologram above the rim of his console. "We'll wallow like a hippopotamus in heat compared to small fighters."

"Then we'll fight them on their terms," said Keith. "We'll defend *Starplex* with our probeships." He glanced at the list Lianne was feeding through to his number-three monitor: geological digging lasers, mining explosives, mass drivers used for launching probes. "Lianne, coordinate with Rhombus on getting as much of that equipment as possible loaded into our five fastest probeships. I want everything aboard in fifteen minutes; I don't care what you have to rip apart to accomplish that."

Denna Van Hausen finally moved away from the ExOps console and Rhombus rolled into place. Manipulator ropes darted across the controls, and Rhombus's sensor web flowed half onto the panel to better interface with the equipment.

"Even with a slapped-together armament," said Thor, "our probeships aren't going to be able to outgun real fighting craft."

"I'm not planning to outgun them," said Keith. "*Starplex* may be of Waldahud construction, but our probeships aren't."

"Granted they may be reluctant to fire on Ibese craft," said Thor, "but—"

"That's not what I'm thinking," said Keith. "Unlike the approaching craft, our probeships weren't designed by

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Waldahud engineers."

"Ah—and we have dolphins to pilot them!" crowed Thor.

"Precisely," said Keith. "PHANTOM, intercom with direct holo links: Longbottle, Thinfin, Nickedfluke, Squint, Sidestripe, respond."

Drawn-out dolphin heads began to pop into existence above Keith's console.

"Here."

"What happening is?"

"Thinfin, acknowledging."

"Yes, Keith?"

"Hello."

"We are about to be attacked by Waldahud craft," said Keith. "Our probeships are more maneuverable—if dolphins pilot them. It will be dangerous, but so will staying here and doing nothing. Are you willing to—"

"Ship is home ocean now—we protect!"

"If necessary, help will I."

"Ready to assist."

"OK."

"I—yes, will do it."

"Excellent," said Keith. "Proceed to launch bays. Rhombus will give you your ship assignments."

Thor looked at his Keith hologram. "There's no doubt that our ships are more responsive—but dolphins have no experience with weapons. They should each have someone else onboard to act as gunner."

Rhombus's web flashed. "Sentients will die if weapons are used."

"We can't stand by and not defend ourselves," declared Thor.

"To surrender our ship is better," said Rhombus.

"No," said Keith. "I refuse to do that."

"But to kill—"

"No one need be killed," said Keith. "We can shoot for the engine units, try to disable the Waldahud ships without breaching their habitats. As for gunners—we're all just scientists and diplomats." He considered for a moment. "PHANTOM, consult personnel records. Who would make the five most proficient gunners?"

"Calculating. Done: Wong, Wai-Jeng. Smith-Tate, Helena. Leed Jelisko em-Layth. Cervantes, Clarissa. Dask Honibo em-Kalch."

"Rissa. . . ?" said Keith under his breath.

"If the object is to fire geological lasers," said Thor, "then why not use Snowflake? She's senior geologist."

"We Ibs have lousy aim," replied Rhombus. "Targeting works better when you have a single point of view."

"PHANTOM," said Keith, "find replacements from other species for the two Waldahudin, and set up an immediate intercom between all of them and me."

"Done. Intercom open."

"This is Director Lansing. PHANTOM has determined that each of you has the training and skill to best operate makeshift weapon systems aboard our five dolphin-piloted probeships. I can't order you, but we need volunteers. Are you up for it?"

A second row of holographic heads appeared above the dolphin faces. "Good God, I—Yes, I'll do it."

"Count me in."

"I'm not sure that I'm the right person, but . . . yes, OK."

"On my way."

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Rissa had moved over to stand next to her husband. "I'll do what I can," she said.

Keith looked at her. "Rissa—"

"Don't worry, honey. I gotta make sure you get to live all those billions of years."

Keith touched her arm. "Rhombus, assign each of them to a ship. PHANTOM, convey them there as fast as possible."

"Doing so."

"Good work, everyone," said Keith, leaning forward in his chair, fingers steepled in front of his face.

"Jesus!" shouted Thor. A tiny explosion was blossoming in the display. "They've shot our watson out of the sky."

"Jag, analyze the weapon used," said Keith. "At least we can figure out what their armament is."

Jag glanced at a square monitor screen. "Standard Waldahud police lasers," he said. But then he rose from his station and gestured toward Melondent, who had been serving as physics officer during delta shift. Jag touched a few keys. "Transferring Physical Sciences to dolphin station one," he said. He turned to Keith. "Perhaps . . . perhaps it would be best if I did not further participate. Gawst did not invoke the name of Queen Trath, so I assume that he and his associates are acting without royal approval—an attempt to garner considerable glory. Still, they are Waldahudin. Perhaps I should return to my apartment."

"Not so bloody fast, Jag," Keith said, rising to his feet. He glanced at Lianne. "Time to launch?"

"Ten, maybe eleven minutes."

Keith turned back to Jag. "You had me move *Starplex* so that we wouldn't be able to see the Waldahud forces massing on the green star's far side."

"I deny that," said Jag, both sets of arms crossed behind his back.

"Your loyalties don't lie with the Waldahudin?"

"My loyalty is to Queen Trath, but there is no evidence that she authorized the attempt to seize this ship."

"Lianne, how many watsons did Jag receive in the last two days?"

"Checking. Three. Two were from CHAT—"

"Which is located just outside the Waldahud home system—" said Keith.

"And the third was a commercial unit from a telecommunications utility on Rehbollo."

"It contained personal news," said Jag, "related to an illness in my family."

"Examine those watsons, Lianne," said Keith. "I want to check the messages that they carried."

"Once I had downloaded the data that I wanted," said Jag, "I released the watsons for re-use—wiping the data first, of course."

"We should be able to recover something," Keith said. "Lianne?"

"Checking," she said, then, a moment later: "OK, the watsons that came for Jag are still on board. We carry over a hundred of them, and those three are still in the queue for reuse." She pressed some keys. "I've interfaced with all three; they're blank."

"Nothing at all to unerase?"

"No. The data area has been wiped, then filled with a random pattern.

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There's nothing left."

"I routinely use a level-seven wipe," said Jag.

"That's two levels above Earth military standards," said Keith.

"It leaves things more tidy," said Jag. "You have often remarked on my predilection for neatness."

"This is all crap," said Keith. "I don't believe that it was coincidence that you asked me to move the ship; the Waldahudin couldn't have attacked *en masse* if we'd been there to see them popping out of the shortcut one by one."

"I tell you, it *is* coincidence," said Jag.

Keith turned to face the InOps station. "Lianne, immediately de-list all command authorities for Jag Kandaro em-Pelsh. And terminate all jobs he has running."

Bleeps as keys were touched. "Doing so," said Lianne.

"You do not have the authority to do this," said Jag.

"So sue me," said Keith. He looked at the Waldahud. "I was one of those who argued against basing any part of *Starplex* on human military structures, but if we had done so, at least we'd have a brig to throw you in." He faced a set of glowing camera eyes floating above the seating gallery behind the workstations. "PHANTOM, record new protocol. Name: 'house arrest.' Authorizing authority, Lansing, G. K. Parameters: Individuals under house arrest are denied access to all work areas; PHANTOM will not open doors for them to such areas. They are also forbidden to use external communication equipment and to give PHANTOM commands above level-four housekeeping. Understand?"

"Yes. Protocol established."

"Record the following: as of this moment—0752 hours—and effective until terminated personally by me, Jag Kandaro em-Pelsh is under house arrest."

"Acknowledged."

Keith's voice was controlled. "Now you may leave the bridge."

Jag folded both sets of arms behind his back again. "I don't believe you have the right to bar me from this room."

"A moment ago, you wanted to leave," said Keith. "Of course, that was back when you had the authority to launch a shuttle, and escape to the armada."

Rhombus had left the External-Ops station and had rolled near to the director's console. Lights played over his sensor web, and the web's strands had turned yellow, the color of rage. "I support Keith," said the cool British voice. "You have undermined everything we have worked for. Leave the bridge voluntarily, Jag, or I will eject you."

"You can't do that. It is against the operating code to assault a fellow sentient."

Rhombus began rolling toward Jag, a living steamroller. "Just watch me," he said.

Jag stood defiant a moment longer. Rhombus closed more of the distance between them, his quartz-rimmed wheels glinting in the starlight of the all-encompassing hologram. The Ib's rope-like tentacles were lifted from their usual bundle, darting in the air

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like angry snakes. Jag finally turned on his heel. The starfield in front of him split open, and he marched out. The door closed.

Keith nodded thanks to Rhombus, then, "Thor, status of the Waldahud ships?"

Thorald Magnor looked over his shoulder at Keith. "Assuming they've got nothing better than standard police lasers, they will be within effective firing range in three minutes."

"How long until our own ships are ready for launch?"

Rhombus's lights blinked out a reply as he rolled back to his workstation. "Two are ready to go now; the other three—grant me another four minutes."

"I want to launch all five at once. Everything goes out the door in two hundred and forty seconds."

"Will do."

"We'll still be outnumbered, eight to five," said Thor.

Keith frowned. "I know that, but it's only our five fastest ships that are set up for dolphin pilots. Rhombus, as soon as our ships are clear of our docking bays, I want full power to our force screens. Cut the engines; divert everything to the screens."

"Will do."

"Lianne," said Keith, "I want to put a message for Tau Ceti in another watson. Shoot this one out a mass-driver tube. Send it on a transfer orbit that'll take it to the shortcut under momentum only; I want it to fly all the way there without using power."

"It'll take a watson three days to get to the shortcut that way," Lianne said.

"I'm aware of that. Calculate the trajectory. How long do I have until our ships launch?"

"Two-point-five minutes," said Rhombus.

Keith nodded, and touched the privacy button that erected four double force-screen walls around his workstation, creating a sound-killing vacuum gap.

"PHANTOM," he said, "search all computer records for research done by Gaf Kandaro em-Weel and his associates, especially for material that's never been translated from Waldahudar."

"Searching. Found."

"Display titles and abstracts in English."

Keith scanned the screen in front of him. "Download into a watson articles 2, 19, and—let's see, better add 21, as well. Encrypt everything under the password Kassabian: K-A-S-S-A-B-I-A-N. Record the following, and add it to the watson as an unencrypted message:

"Keith Lansing to Valentina Ilianov, Provost, New Beijing. Val, we're under attack by Waldahud ships, and I wouldn't be surprised if you're under attack soon, too. I have learned that there is a theoretical way to destroy a shortcut, by flattening spacetime around it, preventing it from anchoring in normal space. If a Waldahud invasion force seems likely to overwhelm your fleet, perhaps you will want to consider destroying your shortcut exit. Doing so will, of course, effectively isolate Sol/Epsilon Indi/Tau Ceti from the rest of the Galaxy, and give the Waldahudin forces no way to retreat. Think long

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and hard before you do this, old friend. The procedure can be gleaned from the articles appended to this message. I've encrypted them. The key is the last name of that woman we both fancied on New New York all those years ago. End."

"Done," said PHANTOM.

Keith tapped a key. The privacy force screens vanished. "Launch the watson, Lianne," he said.

"Doing so."

Keith watched the tiny canister drift away from *Starplex*. His heart was pounding. If Val decided to use the technique, there was one other consequence that Keith hadn't spelled out: he and Rissa and the rest of those from Earth aboard *Starplex* would never see home again.

"Here we go," said Rhombus. "Five. Four. Three. Two. One. Launching *PDQ*. Three. Two. One. Launching *Rum Runner*. Three. Two. One. Launching *Marc Garneau*. Three. Two. One. Launching *Dakterth*. Three. Two. One. Launching *Long March*."

The fusion flares of ten twin engines lit up the holographic sky as the five probeships shot away from *Starplex*'s central disk. The approaching Waldahud ships were now close enough that they could be seen directly, rather than as colored triangles.

"Force screens to maximum," said Rhombus.

"Open windows in the force screens and send the following via scrambled comm laser direct to each of our ships," said Keith. "No one is to fire unless the Waldahudin shoot at us first. Maybe a show of strength will be enough to get them to back down."

"They already creamed one of our watsons," said Thor.

Keith nodded. "But if shots are going to be taken at sentient beings, the Waldahudin are going to have to start it."

"Incoming message," said Lianne.

"Let's see it."

Gawst's face appeared. "Last chance, Lansing. Surrender *Starplex*."

"No reply," said Keith. He glanced at one of his monitors. *Starplex* was still oriented with its lower telescope array facing the green star, and toward the approaching fighters.

"Gawst's ship is coming toward us fast," said Thor. "The other seven are holding position about nine thousand klicks away."

"Steady, everyone," said Keith. "Steady."

"He's firing!" said Thor. "Direct hit on our force screens. No damage."

"How long can we keep deflecting his lasers?" asked Keith.

"Four, maybe five more shots," said Lianne.

"The other Waldahud ships are moving in, trying to surround us," said Thor.

"Do you want our probeships to engage them?" asked Rhombus. Keith said nothing. "Director, do you want our probeships to engage them?"

"I—I didn't think Gawst would really fire," said Keith.

"They're taking up equidistant geodesic positions around us," said Thor. "If all eight ships shoot at us simultaneously and at the same wavelength, it will overload our shields. There will be nowhere to shunt the energy."

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Holograms of the dolphin pilots and their gunners were floating above Keith's console. "Let me take out the ship nearest us," said Rissa, flying with Longbottle aboard the *Rum Runner*.

Keith closed his eyes for a second. When he opened them, he had found his resolve. "Do it."

"Shooting for the engine pod," said Rissa.

PHANTOM drew a red line in the holo sphere to represent the invisible output of the geological laser, lancing from the bow of the *Rum Runner* to the Waldahud craft. The beam sliced along the length of the engine pod, and a plasma tongue shot away from the ship.

"Hey," said Rissa, with a triumphant smile. "Guess all that time playing darts was good for something after all."

"Gawst is firing on *Starplex* again," said Thor. "And one of the other ships is going after the *Rum Runner*."

"Get out of there, Longbottle," said Keith. The *Rum Runner* did an arcing maneuver, exactly like a dolphin doing a backflip. It completed the move with its laser firing in the direction of the incoming ship, which swerved to avoid contact with the beam.

"Gawst's ship has two lasers, one port and one starboard," said Thor. "He's firing them both at our lower radio telescope—man, he's good. He's letting our antenna's parabolic dish focus his beams onto the instrument cluster."

"Rock *Starplex*," said Keith. "Lose him."

The stars in holographic display danced left and right.

"He's still on us," said Thor. "I bet—yup, he's done it. Even with full shields, enough of his laser leaked through, and the dish antenna focussed it. He's taken out the deck-seventy sensor array, and—"

Starplex shook. Keith was startled; he had *never* felt the ship shake before. "The seven remaining Waldahud craft are firing on us in sequence," said Thor.

"Keith to probeships: engage the Waldahudin. Get them to stop their attack on us."

"They'll overload our shields in sixteen seconds," said Lianne.

In the holo display, Keith could see the *PDQ* and the *Long March* firing on two of the Waldahud ships. The Waldahudin were trying to keep a single force screen to their attackers while continuing to fire on *Starplex*, but the probeships were maneuvering wildly, making it hard for the Waldahudin to keep the screen positioned. Glancing blows were making it through.

An alarm started sounding. "Force-screen failure imminent," said PHANTOM's voice.

Suddenly one of the Waldahudin ships exploded silently; the *Marc Garneau* had wheeled from firing on one ship to firing on the same one that the *PDQ* had engaged. The target ship had had no force screens deployed along its bow. Keith lowered his head. The first casualties of the battle—and, with hand-aimed lasers, no one would ever know if gunner Helena Smith-Tate had aimed for the habitat, or had simply missed when

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shooting at the engine pod.

"Two down, six to go," said Thor.

"Force-screen failure," announced Lianne.

The five dolphin-piloted ships began swooping wildly, their weapons firing at random. The holographic display was crisscrossed with animated laser beams, red for the Commonwealth forces, blue for the attackers.

Suddenly Gawst's vessel began revolving around its bow-stern axis, spinning like a corkscrew. "What the hell's he doing?" asked Keith.

It became apparent as PHANTOM drew in the two beams from Gawst's twin laser canons. With the ship rotating, the beams were forming a cylinder of coherent light—turning twin pinpoint weapons into effectively a wide-beam device. Gawst was aiming up, toward the underside of *Starplex*'s central disk, beneath one of the ship's four main generators.

"If he does it right," said Thor, impressed despite himself, "he'll be able to carve out the number-two generator, like a geologist taking a core sample."

"Move the ship!" snapped Keith.

The starfield wheeled. "Doing so—but he's got a tractor beam locked on us. We—"

The ship rocked again, and a new alarm started wailing. Lianne swung around to face Keith. "There's an internal hull breach on deck forty, where the bottom of the ocean deck joins the central shaft. Water is pouring down the shaft into the lower decks."

"Christ!" said Keith. "Did the Ibs screw up when they installed the replacement lower habitats?"

Rhombus's web turned yellow with rage again, and the dots on it flared brightly. "Excuse me?" he said sharply.

Keith raised his hands. "It's just that—"

"The work was done *perfectly*," said Rhombus, "but this ship's designers never thought we would be in a battle."

"Sorry," said Keith. "Lianne, What's the procedure in a situation like this?"

"There is no procedure," said Lianne. "The ocean deck was considered unbreachable."

"Can the water be contained with force fields?" asked Keith.

"Not for long," said Lianne. "The force fields we use in the docking bays have enough strength to hold air at normal pressure against vacuum. But each cubic meter of water masses a full ton; nothing short of the ship's external force-field emitters could hold back that much pressure, and even if Gawst hadn't overloaded those, there's no way to aim them inside the ship."

"If you turn off the artificial gravity in the central disk and on all decks below it, at least the water won't flow down," said Thor.

"Good idea," said Keith. "Lianne, do that."

"Security override," said PHANTOM's voice. "Command disallowed."

Keith shot a look at the PHANTOM camera pair on his console. "What the—?"

"It's because of the Ibs," said Rhombus. "Our circulatory system is based on a gravity feed; we'll die if you turn off the gravity."

"Damn! Lianne, how long to move

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all lbs from decks forty-one through seventy to the upper decks?"

"Thirty-four minutes."

"Begin doing that. And get all dolphins out of the ocean deck—but tell them to stand by with breathing apparatus, in case we have to send them below into the flooded areas."

"If you evacuate starting from deck seventy," said Thor, "you can turn off the gravity there first, and work your way up."

"That won't make any difference," said Lianne. "By the time the water has fallen that far, it'll have enough momentum to continue on downward even if gravity is no longer pulling it."

"What about electrical shorting?" asked Keith.

"I've already shut off the electrical systems in flooded areas," said Lianne.

"If the ocean deck were to drain completely, how much of the lower decks would it fill?" asked Thor.

"One hundred percent," said Lianne.

"Really?" said Keith. "Christ."

"The ocean deck contains 686,000 cubic meters of water," said Lianne, consulting a monitor screen. "Even including all sealed interdeck areas, the entire enclosed volume of the ship below the central disk is only 567,000 cubic meters."

"Excuse me, but I think the *PDQ* is in trouble," said Rhombus, gesturing with one of his ropes toward part of the holographic bubble. Two Waldahud ships were converging on the *Starplex* probeship, lasers crisscrossing.

Keith's eyes darted between the holo display and the monitor on his console showing the progress of the flooding.

"Wait," said Rhombus, "the *Dakterth* is coming up on the stern of the two ships attacking the *PDQ*. It should be able to draw their fire."

"How are the evacuations coming?" asked Keith.

"On schedule," said Lianne.

"Are we leaking any water into space?"

"No; it's just an internal breach."

"How watertight are our interior doors?"

"Well," said Lianne, "the sliding doors between rooms seal when closed, but they aren't strong. After all, the door panels are designed so that anyone can kick them free of their rails for emergency escape in case of fire. The weight of the water will burst them open."

"What genius thought of that?" asked Thor.

"I think he helped design the *Titanic*," muttered Keith.

The ship rocked again, heaving back and forth. In the holo display, a cylinder carved out of *Starplex*'s central disk, ten decks thick, was tumbling against the night. "Gawst has cut out our number-two generator," reported Lianne. "I'd evacuated that part of the engineering torus as soon as he started carving into it, so there were no casualties. But if he can get one more of our generators, this ship won't be able to enter hyperdrive, even if we could get far enough from the star to make that possible."

A burst of light caught Keith's eye. The *Dakterth* had severed the engine

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pod from one of the Waldahud ships that had been firing on the *PDQ*. The pod pinwheeled away. It looked as though it was going to crash into the cylindrical core that had been cut from *Starplex*, but that was only a trick of perspective.

"What if we vent the water out into space?" asked Rhombus.

"We'd have to cut our own hole into the ocean deck to do that," said Lianne.

"Where would be the easiest spot?" asked Keith.

Lianne consulted a schematic. "The rear wall of docking bay sixteen. Behind it is the engineering torus, of course. But right at that location, the torus contains a filtration station for the ocean deck. In other words, it's already filled with water right up to the back wall of the docking bay, so you'd only have to carve a hole in the bay's wall to get water to pour in."

Keith thought for a moment. And then it hit him. "OK," he said, "Get someone with a geological laser down to bay sixteen right away." He turned to Rhombus. "I know the Ibs need gravity, but what if we cut the artificial gravity, and spin the ship instead?"

"Centrifugal force?" said Lianne. "People would be standing on the walls."

"Yes. So?"

"Well, and each deck is cross-shaped, so the apparent force of gravity would increase as you went farther out into each arm."

"But it would also keep the water from flowing down the central shaft," said Keith. "Instead, it would be trying to press against the outer walls of the ocean deck. Thor, could you set up such a spin using our ACS thrusters?"

"Can do."

Keith looked at Rhombus. "How much gravity do you Ibs need for your circulatory systems to work?"

Rhombus lifted his ropes. "Tests have suggested that at least one-eighth of a standard *g* is required."

"Below deck fifty-five," said Lianne, "even at the ends of the arms, we won't get that much apparent gravity at any reasonable rotation rate."

"But that's only fifteen floors that have to have their Ibs evacuated instead of forty," said Keith. "Lianne, inform everyone of what we're doing. Thor, as soon as no Ib is left below deck fifty-five, start spinning the ship. Bleed off the artificial gravity as we come up to speed."

"Will do."

"People should probably vacate the rooms at the ends of each arm, because of the windows," said Lianne.

"Why?" asked Keith. "They're transparent carbon composite; they won't break even if people are standing on them."

"Of course not," said Lianne. "But the windows are angled at forty-five degrees there, because the edges of the habitat modules slope at that angle. It'll be difficult to stand on them once the apparent gravity shifts so that those sloping windows become slanted floors."

Keith nodded. "Good point. Pass on that advisory as well."

"Will do."

The holographic head of Longbot-

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tle aboard the *Rum Runner* spoke up. "Polluted waters we are in. Engines overheating."

Keith nodded at the hologram. "Do what you can; if necessary, head away from us. Maybe no one will follow you."

Starplex rocked again. "Gawst has started carving into the central disk beneath our number-three generator," said Rhombus. "And a second one of his ships is carving in from the top of the disk, right above generator one."

"Start spinning the ship, Thor."

The starfield hologram began to rotate. The ship reeled again. "That took Gawst by surprise," said Thor. "His lasers are skittering across the entire undersurface of the central disk."

Lianne spoke up. "Jessica Fong is in position inside docking bay sixteen, Keith."

"Show me."

A frame appeared around part of the starfield hologram—now spinning at dizzying speed. Inside the frame, a picture of the interior of the docking bay appeared, with a space-suited woman floating in mid-air. She was tethered to the rear wall—the one that was shared with the engineering torus—and the tether was pulled taut as the ship's rotation flung her outward toward the inside of the curving space door. The bay's floor, crisscrossed with landing reference markers, was more than a dozen meters below her feet, and its roof, covered with lighting panels and housings for winches, was a dozen meters above her head.

"Open channel," said Keith, then: "OK, Jessica. Behind the bay's rear wall, inside the engineering torus, is a water-filled ocean-deck filtering station. That station opens on to the ocean on the other side. Drill open a big hole in the docking bay's rear wall. Be careful, though: when you do that, water is going to hammer through at you."

"I understand," said Jessica. She reached to her waist and let out more tether. Keith watched breathlessly as she moved through the air across the bay. She wasn't wasting any time; meters of additional tether appeared each second. She finally reached the far side of the bay, slamming against the curving surface of the space door. For a horrible moment, Keith thought she'd been knocked unconscious by the impact, but she soon recovered from the blow and fought to bring the heavy geological laser into position. She was having trouble holding the unit steady. When she fired, her first shot crossed her own tether line, severing it at its midpoint. Fifteen meters of nylon line came crashing down at her; the other fifteen meters whipped around far over her head like a narrow yellow snake. She was now pinned against the center of the space door by the ship's spinning.

Fong's second shot went equally wild, taking out a junction box for the in-bay lighting system. Everything was plunged into darkness.

"Jessica!"

"I'm still here, Keith. God, this is awkward."

In the frame, all that was visible was black—black, and then a pinprick of ruby, as the laser found the rear wall. Keith watched as the metal

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began to glow, soften, ripple—

—And then—

The sound of water rushing through, like a high-pressure fire hose. Jessica continued to shoot the laser, perforating a giant square along the rear wall. A hole here, move the laser a centimeter, another hole, shoot again, over and over—

The emergency lights came on, bathing the entire bay in red. Sea water erupted from the rear wall. The perforated square of bulkhead metal peeled back, then tore free, flinging across the bay, propelled by a geyser of water behind it.

Keith cringed. It looked as though the metal wall fragment was going to slap against Jessica, who was already being pummeled by wild fists of water, but she, too, must have seen it coming. There was an explosion of flame behind her, scorching the wall. She'd been smart enough to put on a suit with a thruster pack, and had fired herself up and away just in time. The bay was filling with water, starting at the space door and rising in toward the interior wall. Jessica was soon slapped back against the door.

Once the bay had filled, Keith spoke to her once more. "OK, now turn around and drill a hole about ten centimeters in diameter in the outer docking-bay door. Hold the beam emitter right against the door; you don't want to boil the water around you."

"Will do," she said, her space suit now a diving suit. She stood on the space door and held the gray metal cone of her geological laser like a jackhammer. She then fired down between her feet. Soon, part of the space door was glowing cherry red, then white hot, and then, and then. . . .

Starplex spun like a top against the night, green starlight winking off its hull.

The five remaining Waldahud ships were approaching. Two of the ships were coming in from above and three from below, heading toward the ring of docking bays. Doubtless the ship was rotating too fast for any of the Waldahud pilots to notice the tiny incandescent spot in the middle of the door to bay sixteen, a spot that glowed, flared, and burned away. And suddenly—

Water began to spray out into space, flinging away from the rapidly rotating ship. And as it hit vacuum, it evaporated immediately into vapor, and then, once enough vapor had accumulated to make for considerable pressure, the water recondensed into liquid, the plankton, salt crystals, and oceanic detritus providing seeds for droplet formation, and then here, shaded from the green star by the intervening dark-matter field, it froze into ice—

Millions upon millions of ice pellets, flinging away from *Starplex* at high speed, propelled by the explosive force of all the water behind and by the centrifugal force of the rapidly rotating ship. Countless diamonds against the night, winking green in the light of the nearby star—

The first Waldahud ship was hit by a barrage of ice chunks, that ship's speed toward *Starplex* being added to the pellets' own velocity, making for a

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truly high-speed collision. The initial half dozen chunks were deflected by the ship's force screens, shields designed for guarding against single micrometeoroid impacts, not a sustained onslaught. Then—

Ice pellets ripped through the Waldahud hull like teeth through flesh, tearing up the habitat, expelled air freezing and adding to the hailstorm in space.

On the bridge, Keith called out, "Now, Thor! Rock the ship!"

Thor complied. A new streamer of ice chunks angled off in a different direction, impacting a second Waldahud ship, ripping it open. Then a third ship exploded, a silent flower against the dark background, as frozen bullets ripped into the tanks containing its atmospheric-maneuvering fuel.

Thor rocked the ship the other way, and ice pellets were flung toward the fourth remaining ship. By this time, its pilot had come up with a counter-strategy. He rotated his own ship, so that its fusion exhaust cone faced toward *Starplex,* and he fired his main engine, melting the ice into water drops, which immediately boiled into vapor before they could hit his ship. But the pilot of one of the other remaining ships had been unprepared for this maneuver, or too preoccupied with saving his own tail by heading toward the shortcut. His course took him in the path of his comrade's fusion exhaust, and the white-hot flames tore into his vessel. It exploded, leaving only two ships—one of which was Gawst's.

The expanding ring of water pellets deflected most of the ship debris away from *Starplex,* but the crew of the Waldahud craft that had tried the fusion-exhaust trick wasn't so lucky. A large, jagged piece of hull rammed into their ship. The impact set it spinning away, out of control—directly toward the field of dark matter. The pilot seemed almost to regain control when he was a few million kilometers away from the closest of the great gray balls of gas, but by then he was already caught in its gravity. It would take hours for the deadly trajectory to play out its course, but the ship was destined to crash into the darmat—and, at that velocity, even the kind of soft impact that occurred when regular matter hit dark matter would be enough to pulverize the vessel.

Gawst's ship was still intact, holding station with a tractor beam beneath the central disk. There was no way Thor could aim the ice-pellet stream there. Still, *Starplex* could keep spinning until Gawst ran out of fuel, if need be. . . .

"Uh oh." PHANTOM's translation of the rippling lights on Rhombus.

Thor looked up. "God damn," he said.

Emerging from behind the limb of the green star were one . . . two . . . *five* more Waldahud fighters. Gawst had not been fool enough to use all his forces on the initial attack. One of the newcomers was a giant, ten times the size of the smaller probecraft.

Starplex's five dolphin-piloted ships had backed off, avoiding the ice barrage. But now they were linking up in formation, and heading toward the approaching attack force, determined

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to get to it before it could get to their mothership.

And then. . . .

"What the hell?" said Keith, gripping his armrests.

"Jesus—" said Thor. *"Je-sus!"*

The vast field of dark matter had begun to move, slowly at first, but now with gathering speed. It was spinning out into lumpy streamers, greenish on the side facing toward the rogue sun, inky black on the other. The streamers grew longer until they spread out over millions of kilometers, tubes of gravel with planet-sized spheres distributed along their length like knuckles on ethereal fingers.

The *Starplex* probeships dived above or below the streamers. The Waldahud pilots found their ships traveling in erratic courses, unable to compensate for the streamers' gravitational attraction. In the spherical hologram, Keith could see the attacking ships staggering in drunken, weaving lines, pulled off course by the hundreds of Jupiter-masses within each dark-matter ribbon.

The streamers were growing with surprising speed. Keith still had trouble with the concept of macrolife living freely in space, but of course most lifeforms could move quickly when they wanted to.

The pilots of the incoming Waldahud ships were realizing that they were in trouble. One of them aborted what had clearly been an attack run toward *Starplex,* and was now veering off at a steep angle. Another fired its braking jets, the exhausts four ruby pinpricks against the blackness. But the darmats continued to reach for them, long, puffy fingers against the night.

If the ships had been able to use hyperdrive, they could have escaped. But the gravity well from the green star, and the shallower but still significant wells created by the darmats, prevented that.

The farthest of the new fighters was now only a few kilometers ahead of one of the dark-matter tendrils. Keith watched as the gap was closed, the ship disappearing within the fog of gravel.

Thor provided a schematic, showing the fighter's position within the streamer—a streamer which now was no longer reaching forward, but had started pulling back, its gravity dragging the Waldahud vessel with it. . . .

Soon a second dark-matter tentacle had enveloped another Waldahud ship. A third fighter was trying desperately to get away; Keith could see the flash of explosive bolts as it jettisoned its weapons clusters in order to decrease its overall mass. But the dark matter was still gaining on it.

Meanwhile, the two tendrils that had already caught ships were still pulling back, and—that was curious—had begun curling in on themselves, arching away, like cobras made of ash.

The third small ship was finally caught, and its gray finger started pulling back, too. The giant Waldahud ship was also being approached from above and below by separate dark-matter tentacles. Only the fifth new ship seemed likely to get away, although Keith's heart was pounding as he saw that Rissa and Longbottle were

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now pursuing it. His son's face flashed in front of his eyes—still a kid at nineteen, the goatee notwithstanding. How would he break the news to him if his mother got killed?

The first two tentacles had arched back into semicircles, the cups of which were facing away from the green star. At the same moment as the large vessel was engulfed by the two converging streamers that had been pursuing it, the first of the dark-matter fingers snapped forward like a whip. The Waldahud fighter that had been embedded in it shot ahead, out of the tentacle, tumbling end over end. Keith saw the pinpoint lights of ACS jets firing, but the ship's wild rotation continued unabated as—

Keith's jaw fell open. *Good Christ*—!

—As the ship was flung directly toward the green star.

The vessel continued to rotate over and over as the distance between it and the star diminished rapidly. The pilot finally managed to gain control, but he was too close to the 1.5-million-kilometer-wide ball of fire. Prominences licked toward the incoming projectile—

—And the ship turned to vapor in the star's upper atmosphere.

Keith shouted, "Rhombus, hail our probeships!"

"Channel open."

"Return to *Starplex*!" said Keith. "All ships, return at once to *Starplex*!"

Four probeships acknowledged and changed course, but one was still pursuing its target.

"Rissa!" Keith shouted. "Turn back!"

Suddenly the second dark-matter whip cracked across the night, sending another Waldahud ship hurtling toward the green star. Keith's head kept snapping left and right between the twin horrors of Rissa's ship receding from *Starplex* and the fighter's head-over-heels rush toward destruction.

The *Rum Runner* was corkscrewing wildly as it approached the enemy vessel. Laser fire from the Waldahud's rear canons kept missing the probeship, or glancing off its force screens. But, after a moment, the firing stopped as the Waldahudin aboard presumably became absorbed in the spectacle they, too, were no doubt monitoring.

The second ship the darmats had tossed toward the sun was rapidly reaching its destination. Lifeboats popped away from it, but their puny motors weren't strong enough to let them achieve orbit around the star. The last sight the dying Waldahudin probably saw on their monitor screens was the star's strange dumbbell-shaped sunspots, gray-black splotches against a hell of liquid jade.

The *PDQ* and the *Dakterth* were returning to *Starplex* now. Of course, they had to approach from above or below to avoid the torus of hail surrounding the ship. Rhombus was using tractor beams to pull them down onto the flat surface of the central disk. There was no way to get them into the docking bays—the ice prevented that—but there were emergency docking clamps on both faces of the disk.

Rum Runner was still giving chase. "Rissa!" shouted Keith into his mike.

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"For God's sake, Rissa—come home!"

Suddenly the *Rum Runner*'s laser erupted, PHANTOM dutifully drawing in its beam on the holographic display. It swept across the starscape. Rissa's aim was perfect, severing the ship's engine pod from the craft in one clean slice. The pod tumbled against the night, a puff of expelled gas around it shining like a halo of emeralds. And suddenly—

The pod flared brilliantly, brighter even than the nearby star, as it went up in a fusion explosion. Longbottle executed a crazed arcing maneuver to avoid the expanding ball of plasma, then began a laser-straight path for *Starplex*. The engineless Waldahud ship shot away at an oblique angle under momentum, unable to maneuver.

The third dark-matter whip cracked, sending another Waldahud fighter pinwheeling across the firmament. As this one passed by, Keith saw that several of its hull plates had been deliberately blown away; the crew had apparently preferred opening the ship to vacuum over cooking alive as they plunged into the sun.

Next the combined double finger that had enveloped the huge Waldahud ship began to rotate around its midpoint, playing out into a spiral design like a galaxy as it did so, turning faster and faster. PHANTOM showed the location of the ship buried within one arm of the spinning mass. The rotation became more and more rapid, until finally, like an athlete throwing a discus, the dark matter hurtled the giant ship away from it. The bigger ship managed to regain control before it impacted the sun, but as it started to alter its course, the white fusion flames of its exhaust stark against the green inferno, a giant prominence arched upward from the photosphere, engulfing it.

"Four of our five probeships are safely clamped to our hull," reported Rhombus. "And the *Rum Runner* will be back in eleven minutes."

Keith let out a heavy sigh. "Excellent. We must have everyone out of the lower decks by now, right?"

"The final elevator is on its way up," said Lianne. "Give it another thirty seconds."

"OK. Keep the lower decks at zero-*g*, so no more water will flow down. Thor, stop spinning the ship."

"Will do."

"Director," said Rhombus, "Gawst's ship has attached itself to the surface of our hull. He's holding in place with a tractor beam."

Keith smiled. "Fancy that—a prisoner of war." He spoke loudly. "Excellent work, everyone. Thor, Lianne, Rhombus—excellent." He paused. "Thank God the darmats sided with us. I guess it never hurts to be on speaking terms with the stuff that makes up most of the Universe, and—"

"Jesus." Thor's voice.

Keith's head snapped up to face the pilot. He'd spoken too soon. Tendrils of dark matter were now closing on *Starplex*.

"We're next," said Rhombus.

"But we're orders of magnitude bigger than the Waldahud ships," said Thor. "Surely they can't toss us into the star?"

"Only a third of the dark matter participated in the attack on the Wal-

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dahud forces," said Rhombus. "If it all comes after us—PHANTOM, can they do it?"

"Yes."

"Hail Cat's Eye," said Keith. "I better talk to him."

"Locating vacant frequency," said Rhombus. "Transmitting. No response."

"Thor, get us out of here," said Keith.

"Course?"

Keith considered for half a second. "Toward the shortcut." But he immediately realized that dark-matter tendrils had already started to intervene between *Starplex* and that invisible point in space. "No, change that," he snapped. "Bring us in close to the green star, in the opposite direction. And get Jag down here, PHANTOM."

"You ordered him barred from this room, sir," said the computer.

"I know that. I'm giving you new instructions. Get him down here right away."

There was a moment's silence while PHANTOM conferred with Jag. "He is on his way."

"What've you got in mind?" asked Rhombus. Dark matter was approaching *Starplex* on three sides, like a fist closing around a bug.

"Hopefully, a way to get out of here—if it doesn't kill us."

The starfield split open, and Jag walked in. For the first time, Keith saw a look of humility on the Waldahud's face. Jag had presumably been watching the space battle, and had seen his compatriots slammed into the emerald star. But still some of the old defiance was in his voice as he looked suspiciously at Keith. "What do you want?"

"I want," said Keith, his voice tightly controlled, "to slingshot *Starplex* around the green star, and hurtle it into the shortcut from the far side."

"Jesus God," said Thor.

Jag grunted a similar sentiment in his own language.

"Can it be done?" said Keith. "Will it work?"

"I—I don't know," said Jag. "I would normally like a few hours to do the calculations for something like that."

"You don't have hours—you've got minutes. Will it work?"

"I do not—yes. Maybe."

"Melondent," said Keith, "transfer control back to Jag's station."

"So doing," said the dolphin.

Jag slipped into his usual spot. "Central Computer," he barked, "put our trajectory on this monitor."

"You are barred from issuing non-housekeeping commands," said PHANTOM.

"Override!" snapped Keith. "Jag's house arrest is suspended until further notice."

The requested schematic appeared. Jag squinted at it. "Magnor?"

"Yes?" said Thor.

"We have only perhaps ten minutes until we are engulfed. You will need to fire all our ventral thrusters. Copy my monitor six in touch-screen mode."

Thor pressed buttons. "OK."

Jag ran a flat finger in an arc along the schematic. "Can you manage a course like that?"

"You mean on manual?"

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"Yes, on manual. We have no time to program the run."

"I—yes, I can do it."

"Execute it. Execute it now!"

"Director?"

"How long until the *Rum Runner* is anchored to our hull?"

"Four minutes," said Rhombus.

"We don't have the time to wait for her," said Jag.

Keith turned to snap at Jag, but stopped himself. "Options?" he said generally to the people on bridge.

"I can put a tractor beam on the *Rum Runner,*" said Rhombus. "I won't be able to haul her in before we hit the shortcut, but she should be dragged over to it with us and then hopefully Longbottle can pilot it through."

"Do that. Thor, get us out of here."

Starplex rushed toward the star at an oblique angle. "Thrusters on full," said Thor.

"There's another problem we still have to deal with," said Jag, turning to Keith. "There's a good chance that I can get us to the shortcut, but once there, we'll just plunge through it. We won't have any time to slow down and do a controlled approach at a specific angle, and with our deck-seventy hyperscope array damaged I can't even predict which exit we'll pop out of. It could be anywhere."

The dark-matter fingers were still stretching toward *Starplex*. "In a few minutes, anywhere will be preferable to this place," said Keith. "Just get us out of here."

The ship began to careen around the star. Half of the bridge hologram showed the green orb, its granular surface detail and dumbbell sunspots visible. Most of the rest of the view was cloudy, with dark-matter tendrils eclipsing the background stars. "Rhombus, do you have a solid lock on the *Rum Runner*?"

"It's still four hundred kilometers away, and dark matter is starting to intervene, but, yes, I've got it."

Keith breathed a sigh of relief. "Good work. Have you been able to contact Cat's Eye, or any darmat?"

"They're still ignoring our hails," said Rhombus.

"We can't go in as close to the star as I would like," said Jag. "There's not enough water left in the ocean deck to make an effective shield, and our force screens are still burned out. There's a thirty percent chance that the darmats will ensnare us."

Keith felt his heart pounding in his chest. *Starplex* continued to swing around the star in a parabolic course, the tendrils still stretching toward it. The *Rum Runner* was indicated in the holo bubble as a tiny square, with an animated yellow tractor beam lancing out to it. The starfield wheeled—Thor was angling the ship as they grazed the star's atmosphere.

Finally, *Starplex* reached the cusp of the parabola and, picking up enormous velocity from slingshotting around the star, raced toward the shortcut. In the holo bubble, PHANTOM brightened the yellow tractor-beam animation, indicating that additional power was being pumped into it. *Starplex*'s course, four hundred kilometers closer to the star, was significantly different from the path the *Rum Runner* would have been fol-

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lowing if it had been looping around the orb under its own momentum.

"Two minutes to contact with the shortcut, mark," said Rhombus.

"We've never gone through a shortcut this fast before—no one has," said Jag. "People should secure themselves, or at least hold on to something."

"Lianne, pass on that recommendation to all aboard," said Keith.

"All personnel," said Lianne's voice, reverberating over the speakers, "brace for possible turbulence."

Suddenly a large, irregular object eclipsed part of the view. "Gawst's ship," said Lianne. "He's pushed off our hull. Probably thinks we've all gone insane."

"I could grab him with another tractor," said Rhombus.

Keith smiled. "No, let him go. If he thinks his chances are better with the darmats, that's fine by me."

"Eighty seconds, mark," said Rhombus, orange clamps rising up from the invisible floor to hold onto his wheels.

"One point four degrees to port, Magnor," said Jag. "You're going to miss the shortcut."

"Adjusting course."

"Sixty seconds, mark."

"Everyone hold on," said Lianne. "It's—"

Blackness. Weightlessness.

"God damn it!" Thor's voice.

Barking—Jag speaking. No translation from PHANTOM.

Flickering lights—the only illumination in the room: Rhombus saying something.

"Power failure!" shouted Thor.

Red emergency lighting came on, as did emergency gravity—a priority because of the Ibs. There were loud splashing sounds from either side of the room: the water in the dolphin workstations had swelled up into great dome shapes under zero gravity, domes which had collapsed, splattering liquid everywhere as weight returned.

No holographic bubble surrounded the bridge; instead its blue-gray plastiform walls were visible. Keith was still in his chair, but Jag was on the floor, obviously having lost his balance during the brief period of zero-*g*.

The three consoles in the front row—InOps, Helm, and ExOps—flickered back into life. The back-row stations were less critical, and stayed off, conserving battery power.

"We've lost the *Rum Runner*," said Rhombus. "It was cut loose when the tractor beam died."

"Abort the shortcut insertion!" snapped Keith.

"Way too late for that," said Thor. "We're going through under momentum."

Keith closed his eyes. "Which way did the *Rum Runner* go?"

"No way to tell until I get my scanners back online," said Rhombus, "but—well, we were hauling her in, meaning she would have been moving pretty much in a line back toward the green star—"

"The number-one generator blew," interjected Lianne, consulting readouts. "Battle damage. I'm switching over to standby generators."

PHANTOM's voice: "Re-in-ish-il-i-zing. Online."

The holographic bubble reformed,

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beginning as a burst of whiteness all around them, then settling down to the exterior view, dominated by the green star, the rest obscured by the pursuing tendrils of dark matter. Keith looked in vain for any sign of the *Rum Runner*.

Thor's voice: "Ten seconds to shortcut insertion, mark. Nine. Eight."

Lianne's voice, overtop, coming from the public-address speakers. "We should have full power back in sixty seconds. Prepare—"

"Two. One. Contact!" The red emergency lighting flickered. The shortcut appeared like a ring of violet arcing around them, visible above their heads and beneath their feet, as the infinitesimal point expanded to swallow the massive ship.

Everything to the stern of the ring was the now-familiar sky of the green star and the pursuing dark matter. But in front of the ring was an almost completely black sky. The passage through the shortcut took only a few moments as *Starplex* hurtled through at breakneck speed.

Keith shuddered as he realized what had happened. Rhombus's lights swirled in patterns of astonishment. Lianne made a small sound in her throat. Jag was reflexively smoothing his fur.

All around was black emptiness, except for an indistinct white oval and three smaller white splotches high above their heads, and a handful of fainter white smudges tossed at random against the night.

They had emerged in the empty void of intergalactic space. The white splotches weren't stars; they were whole galaxies.

And not one of them looked like the Milky Way.

CHAPTER 18

Rissa felt her throat constricting as the *Rum Runner* was flung away from *Starplex*.

"What happened?" she called.

But Longbottle was too busy to answer. He was twisting and turning in his tank, fighting to bring the ship under control. On her monitors, Rissa saw the green star swelling ahead of them, its surface a roiling ocean of fiery emerald, jade, and malachite.

She fought down a wave of panic, and tried to assess for herself what had gone wrong. There's no way Keith would have cut power to the tractor beam, so either Gawst had used some sort of interfering transmission to severe the tractor, or *Starplex* had suffered a power failure. Either way, they'd been hurled away from the mothership, and almost directly toward the star. Through the clear wall between her air-filled chamber and Longbottle's water-filled one, Rissa saw the dolphin sharply arching his body in what seemed to be a painful way, and bashing the side of his head against the opposite wall, as if by that sheer additional effort he could force the ship in the direction he wanted it to go.

Rissa looked at her monitors, and her heart skipped a beat. She saw *Starplex* disappear through the shortcut to—to wherever it had gone. The great ship's windows were dark, confirming that a power failure must have occurred. If the ship was truly with-

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out power, Rissa hoped it had come through the shortcut network at New Beijing or Flatland—where there would be other vessels to help it. Otherwise, it might not be able to return through whatever exit it emerged from—and a search of all the active exits might not be completed before *Starplex*'s batteries ran out, leaving it without life support.

But Rissa only had a few moments to think about the fate of her husband and colleagues; the *Rum Runner* was still heading toward the green star. The bow window had already darkened considerably, trying to filter out the inferno ahead of them. Longbottle was still struggling with the controls attached to his flukes and fins. Suddenly he flipped around in his tank, and Rissa saw the green star wheel away from view. Longbottle was bringing the main engines around to face the star, and firing them as brakes. The ship rattled; Rissa could see Longbottle disabling emergency cutoffs with presses of his snout.

"Sharks!" shrieked Longbottle. At first, Rissa thought it was just a swear word for the dolphin, but then she saw what he was referring to: tendrils of dark matter were now obscuring half the sky, the gray spheres within the miasma of luster-quark gravel like the knots on a cat-o'-nine-tails.

Longbottle twisted to his right, and the ship followed suit. But soon a much more sharply defined blackness obscured their view.

"Ship of Gawst," said Longbottle.

"Damn," said Rissa. She brought her hands down on the two grips that controlled the geological laser. She wasn't going to fire unless he did, but—

Ruby dots on Gawst's hull. Rissa moved her thumb over the laser's twin triggers.

Longbottle must have seen her do that. "ACS jets," he said. "Not lasers. He too tries to get away from darmats."

The view in the window changed again as Longbottle altered the *Rum Runner*'s course. Green star to the rear, enemy ship to port, darmats to starboard and coming in above and below. There was only one course possible. Longbottle jabbed controls with his snout. "To the shortcut!" he shouted in his high-pitched voice.

Rissa flipped keys, and one of her monitors showed the hyperspace map, the maelstrom of tachyons visible around the exit point.

"More maneuverable are we than *Starplex*," said Longbottle. "An exit we may choose."

Rissa thought for half a second. "Can you tell where Keith and the others went?"

"No. Shortcut rotates; I can match their angle of approach, but no time to work out if that will mean we exit at the same place."

"Then—then go for New Beijing," said Rissa. "*Starplex* will eventually end up there for repairs—if it can."

Longbottle squirmed in his tank, and the *Rum Runner* arched upward then down, coming at the shortcut from above and behind. "Insertion in seconds five," he said.

Rissa held her breath. There was nothing visible on her monitors. Nothing at all—

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A flash of purple.

A different starfield.

A massive black starship.

A starship firing on a flotilla of United Nations vessels.

Four—no, five!—dead hulks pinwheeling against the night, surrounded by clouds of expelled atmosphere.

Everything was bathed in bloody light from the red dwarf that had recently emerged from this shortcut.

It flashed in front of Rissa's eyes, the words fully formed, like a chapter title on some future textbook screen—

The Rout of Tau Ceti.

Waldahud forces attacking the Earth colony, seizing the one shortcut that serviced human space, a giant battle cruiser easily dispatching the tiny diplomatic craft normally stationed there—

A giant battle cruiser that had all its force screens aimed forward, protecting it from the return fire being launched by the UN ships—

A giant battle cruiser that the *Rum Runner* was directly behind.

Rissa had never killed before, had never even deliberately injured before, had—

The Rout of Tau Ceti.

She swung the handles that aimed the laser, and leaned on the triggers.

PHANTOM wasn't here to animate in the beam for her, and the Waldahudin battleship was too far away for her to see the red dot moving across its hull—

Moving across its thruster fuel storage tanks—

Ripping them open—

Igniting the fuel—

And then—

A ball of light, like a supernova—

The bow window going completely black—

Longbottle arching in his tank, moving the *Rum Runner* away from the expanding sphere of debris.

Rissa took her hands off the triggers. The window grew clear again. She was shaking from head to foot. How many Waldahudin had been aboard a ship that size? A hundred? A thousand? If they'd planned to actually move on to Sol system and storm Earth and Mars and Luna, perhaps as many as ten thousand soldiers—

All dead.

Dead.

There were other Waldahudin ships in the area, but they were tiny one-person fighter craft. The big black vessel must have been their mothership.

Rissa exhaled noisily.

"You acted well," said Longbottle, gently. "You did what you had to."

She said nothing.

The UN ships were banking now—New Beijing was a human-*dolphin* colony—and coming in to attack the small Waldahud fighters. The *Rum Runner* buffeted slightly as it passed through the cloud of expelled atmosphere from the destroyed battleship.

Rissa's console beeped. She looked at the glowing red indicator, like a drop of blood, but did not move. Longbottle eyed her for a moment, then nosed the similar control in his tank. A woman's voice came over the speakers. "This is Liv Amundsen, commander of the United Nations police forces at Tau Ceti, to *Starplex* auxiliary craft." Rissa glanced at her

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monitors. Amundsen's ship was still three light-minutes away; no point in trying a real-time conversation. "We have identified your transponder signal. Thank you for your timely arrival. Our casualties are heavy—over two hundred dead—but you've saved New Beijing. You can bet they'll pin a medal on your chest, whoever you are aboard that ship. Over."

A medal, thought Rissa. Jesus Christ, they give medals.

"Rissa?" said Longbottle. "Do you want me—?"

Rissa shook her head. "No. No, I'll do it." She tapped a key. "This is Dr. Clarissa Cervantes aboard the *Rum Runner*; I'm here with a dolphin pilot named Longbottle. *Starplex* was also attacked by Waldahud forces; it headed through the shortcut network to destination unknown, but may require emergency drydock facilities. Can you accommodate?"

She watched the stars drift by as she waited for her signal to reach Amundsen's ship, and the reply to make its way back. *The Waldahud forces were repelled at Tau Ceti,* said the history book in her mind. But what was the next chapter? Two hundred from Earth or its colonies were dead.... Dolphins didn't believe in vengeance, but would the humans demand it? Would this be the one skirmish, or were we about to see all-out war?

"Negative, Dr. Cervantes," came Amundsen's voice, at last. "Our dock facilities were the first thing the Waldahudin fired on." Of course, thought Rissa. Pearl Harbor all over again. "Suggest *Starplex* try the Flatland drydocks—although it should be careful when moving through the shortcut to there. Remember, a G-class subgiant recently emerged from that shortcut. We can, however, offer repair services here for a small ship such as yours."

Rissa looked at her monitors. The battle wasn't quite over. Police ships were still engaging a few Waldahud craft, although some of the invaders seemed to have surrendered, jettisoning their own engine pods.

"We more fuel need," said Longbottle to Rissa. "And thrusters must be allowed to cool—I overworked them badly."

"Fine," said Rissa into her microphone. "We're coming in." She nodded to Longbottle, and he rotated in his tank, moving the ship. Rissa's heart was still pounding. She closed her eyes, and tried not to think of what she had done.

CHAPTER 19

"Lianne, damage report!" snapped Keith.

"I'm still tabulating everything from the battle, but there were no new problems caused by the high-speed shortcut passage."

"What about casualties?"

Lianne tilted her head, listening to reports over her audio implant. "No deaths. Lots of bone fractures, though. Couple of concussions. Nothing too serious. And Jessica Fong got out of docking bay sixteen all right, although she has a broken hip and arm, and a lot of bruising."

Keith nodded and breathed a sigh of relief. He looked around the holo bubble, trying to make out detail in the faint smudges of white against

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black infinity. "God," he said under his breath.

"All the gods," replied Jag, softly, "are a very, very long way from here."

Thor turned around and looked at Jag. "It *is* intergalactic space, isn't it?"

Jag lifted his upper shoulders in agreement.

"But—but I've never heard of any shortcut exit this far out," said Lianne.

"The shortcuts have only existed for a finite time," said Jag. "Even hyperspace signals from one in intergalactic space might not have reached any of the Commonwealth worlds yet."

"But how can there be a shortcut in intergalactic space?" asked Thor. "What's it anchored to?"

"That's a very good question," said Jag, bending his head down to look at his instruments. "Ah—there it is. Check your hyperspace scanner, Magnor. There's a large black hole about six light-hours from here."

Thor let out a low whistle. "Adjusting course. Let's give it a wide berth."

"Are we in any danger from it?" asked Keith.

"Not much, boss—unless I fall asleep at the wheel."

Jag touched some controls, and a framed-off area appeared in the holo bubble. But the space inside the frame was just as empty and black as the space outside it.

"Normally you can see the accretion disk around a black hole," said Jag, "but there's nothing out here to be pulled into it." He paused. "My guess is that it's an ancient black hole—it would have needed billions of years to get out here. I suspect it's the remains of a binary star system. When the larger component went supernova, it could have caused an asymmetric kick which propelled the resulting black hole out of its home galaxy."

"But what would have activated this shortcut?" asked Lianne.

Jag lifted all four shoulders. "The hole would pull in any matter that wanders by. Something that was being sucked in by it probably fell through the shortcut instead." Jag tried to sound jaunty, but it was clear even he was staggered by it all. "We're actually pretty lucky—shortcuts in intergalactic space are probably as rare as mud without footprints."

Keith turned to Thor. He made an effort to keep his voice calm, controlled. He was the director; no matter how much *Starplex* usually behaved like a research lab rather than a sailing vessel, he knew all eyes would be on him, looking for strength. "How soon can we go back through the shortcut?" he asked. "How soon can we go get the *Rum Runner*?"

"We've still got major electrical problems," said Lianne. "I wouldn't want to move the ship until those are stabilized—and I'll need at least three hours for that."

"Three hours!" said Keith. "But—"

"I'll try to cut it down," said Lianne.

"What about sending a probeship through to help Rissa and Longbottle?" asked Keith.

The room was silent for a moment. Rhombus rolled over to the command workstation, and touched Keith's forearm lightly with one of his manipulator ropes. "My friend," he said, PHAN-

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TOM translating the low intensity of his lights as whispering, "you can't do that. You can't put another ship in danger."

I'm the director, thought Keith. *I can do what I damn well please.* He shook his head, trying to get control. If anything had happened to Rissa. . . .

"You're right," he said at last. "Thanks." He turned to Jag, and felt his heart rate increasing. "I should put you back under house arrest, you—"

"'Pig,'" said Jag, his underlying bark an excellent mimicking of the English word. "Go ahead and say it."

"My wife is out there somewhere—possibly dying. Longbottle, too. What the hell were you trying to accomplish?"

"I admit nothing."

"The damage to this ship will cost billions to repair. The Commonwealth will bring charges against you, you can be sure of that—"

"You will never be able to prove that my request to move *Starplex* had anything to do with the subsequent events. You can revile me all you wish, human, but even your unenlightened courts require proof to substantiate a charge. The dark-matter being I wanted to examine did indeed have an unusual hyperspace footprint; any astronomer will verify that. And it was indeed invisible from *Starplex*'s vantage point before the move—"

"You said that darmat was about to reproduce. It hasn't done a thing."

"You are spoiled by being a sociologist, Lansing. In the hard sciences, we occasionally have to face the reality that some of our theories will actually be disproven."

"It was a ruse—"

"It was an experiment. Suggesting anything else is conjecture; persist publicly in it, and I shall bring defamation charges against you."

"You bastard. If Rissa dies—"

"If Dr. Cervantes dies, I will mourn. I wish her no ill. But for all we know, she and Longbottle have maneuvered through the shortcut to safety. It is *my* compatriots who have died today, not yours."

Lianne spoke softly from her console. "He's right, Keith. We've lost equipment, and we've got several people who are injured. But no one from *Starplex* is dead."

"Except possibly Rissa and Longbottle," snapped Keith. He took a deep breath, trying to calm himself. "It's all about money, isn't it, Jag? Of all the Commonwealth homeworlds, Rehbollo's economy took the biggest hit when interstellar commerce opened up. You guys never build two things the same—"

"To do so is an affront to the God of Artisans—"

"To do so is efficient, and your factories and workers were not. So you tried to goose the government coffers. Even disassembled for parts, *Starplex* would be worth trillions—lots of glory in that. And if war erupted over its seizure, well, nothing like a little war to give the economy a boost, eh?"

"No sane being wants war," said Jag.

"PHANTOM," snapped Keith, "Jag is again under house arrest."

"Acknowledged."

"It may please the punitive in you

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to do that," barked Jag. "But this is still a science vessel, and we are the first Commonwealth beings ever to be in intergalactic space. We should determine our exact location—and I am the most-qualified person to undertake that task. Rescind the arrest order, shut up and leave me alone, and I shall try to figure out where we are."

"Boss," said Thor, gently, "he's right, you know. Let him help."

Keith fumed for a few moments longer, then nodded curtly. But when he did nothing further, Thor spoke into the air. "PHANTOM," he said. "Cancel house arrest on Jag."

"Cancellation requires authorization from Director Lansing."

Keith exhaled noisily. "Do it—but, PHANTOM, monitor every command he issues. If any of them seem unrelated to determining our location, notify me at once."

"Acknowledged. House arrest ended."

Keith looked at Thor. "What's our current heading?"

Thor consulted his instruments. "We're still on a modified version of the parabolic course we used to slingshot around the green star. Obviously, the path changed when we ceased to be under that star's gravitational influence, so—"

"Magnor," said Jag, interrupting. "I need you to rotate the ship in a Gaf Wayfarer pattern; we are missing one hyperscope array, but I need a parallactic full-sky hyperspace scan."

Thor tapped some keys. The holographic bubble around the bridge began a complex series of rotations, but because the bubble was empty save for a few indistinct smudges of white, the tilting and turning didn't cause vertigo. The pilot looked at Keith again. "As for getting home, the shortcut exit behind us shows in hyperspace just like every other one I've ever seen, complete with zero meridian. Assuming the damned things still work the same way over millions of light-years, once Lianne gets our full electrical system back online, I should be able to put us back at any active shortcut you specify."

"Good," said Keith. "Lianne, how badly damaged were we in the battle?"

"Decks fifty-four through seventy are flooded," she said, into a hologram of Keith's head, "and everything from deck forty-one down has some water damage. Also, all decks below the central disk took a heavy hit of radiation as we careened around the green star; I advise declaring the entire lower half uninhabitable." She paused. "The *Starplex 2* team is going to be pissed off with us—we've now fried both sets of lower habitat modules."

"What about our shields?"

"Our force-field emitters were all overloaded, but I've already got my engineers working on repairs; we should have minimal screens within an hour. In a way, it's good we came out in intergalactic space. The chances of running into a micrometeoroid out here are slim."

"What about the damage done when Gawst carved out our number-two generator?"

"My teams have put temporary bulkheads in place around the hole

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where it was removed," said Lianne. "That should hold until we get back to a spacedock."

"And the other generators?"

"Number three has had all its electrical connections severed. I've got a crew working on hooking it back up again, but I don't know if we've got enough wide-gauge fiber-optic cable in stock to do the job; we may have to manufacture some. Anyway, until we get it back online, we won't be able to use the main engines. One of the other Waldahud ships had started carving out the number-one generator, as well. That's the one that quit, causing the power failure. We should be able to repair that damage, though."

"And what about the docking bays?"

"Bay sixteen is filled with frozen water," said Lianne. "Also, three of the five probeships that were involved in the battle are in need of repairs."

"But we're still spaceworthy?" asked Keith.

"I want to schedule about three weeks in dock for repairs, but, yes, we're in no immediate danger."

Keith nodded. "In that case, Thor, as soon as Lianne says we're ready for powered flight, I'll want you to plot a course through the shortcut that will pop us out where we started, back near the green star."

Thor's orange eyebrows lifted. "I know you want to rescue the *Rum Runner*, Keith, but if they survived, Longbottle will have already taken them out of there through the shortcut."

"Probably so, but that's not why I want to go back." He looked over at Rhombus. "You were right a few minutes ago, my rolling friend. I've got to keep my priorities straight. Contact with other life is why *Starplex* was built in the first place. I'm not going to let the Commonwealth become like the Slammers, cutting off all communication because of a misunderstanding. I want to talk to the darmats again."

"They tried to kill us," said Thor.

Keith raised a hand. "I'm not fool enough to give them a second chance to toss us into the green star. Can you plot a course that will bring us out of the shortcut, whip us around that star, then bring us back to the shortcut, diving through on a vector that will take us out at the Flatland 368A exit?"

Thor considered for a moment. "I can do that, yes. But F368A? Not New Beijing?"

"For all we know, the attack on *Starplex* was not an isolated event. New Beijing may be under siege. I want to go to a neutral location." A pause. "Now, with the course I've described, will the darmats be able to grab us again?"

Thor shook his head. "Not at the speed we'll be going, unless they're all lying in wait for us just outside the exit."

"Rhombus," said Keith, "as soon as Lianne's got the appropriate systems back online, send a probe through to the green-star exit. Include a hyperspace scanner on it, so you can locate the darmats by the dents they make in spacetime. Also, have it do a wide-spectrum radio scan, in case Waldahud reinforcements have arrived. And"—Keith tried to keep his voice

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calm—"have it check for the *Rum Runner*'s transponder code."

"It'll be at least thirty minutes before we can do that," said Lianne.

Keith pursed his lips, and thought about Rissa. If she were gone, it would take all the billions of years he had left to get over the loss. He looked at the smudges of galactic light against the abyss. He didn't even know which direction to look in, which way to concentrate his thoughts. He felt incredibly small, insignificant, and lonely beyond belief. There was nothing to focus on in the holo bubble—nothing sharp, nothing well-defined. Just an abyss—an ego-crushing emptiness.

Suddenly there was a strange sound like a dog's cough from his left; PHANTOM translated it as an expression of "absolute astonishment." Keith turned to face Jag, and his mouth hung open as he stared at the Waldahud. He'd never seen Jag's fur do *that* before. "What's wrong?"

"I—I know where we are," said Jag.

Keith looked at him. "Yes?"

"You're aware that the Milky Way and Andromeda have about forty smaller galaxies bound to them gravitationally, right?" said Jag.

"The Local Group," said Keith, irritated.

"Exactly," said Jag. "Well, I started off by trying to find some of the Local Group's distinctive features, such as superbright S Doradus in the Large Magellanic Cloud. But that didn't work. So I sorted the catalog of known extragalactic pulsars by distance—which corresponds to age, of course—and used their signature radio pulses to orient myself."

"Yes, yes," said Keith. "And?"

"And the closest galaxy to us right now is that one there." Jag pointed beneath his feet to a fuzzy spot in the hologram. "It's about five hundred thousand light-years from here. I have identified it as CGC 1008; it has several unique attributes."

"All right," said Keith, sharply. "We're half a million light years from CGC 1008. Now, for us non-astrophysics types, how far is CGC 1008 from the Milky Way?"

Jag's barking was subdued, almost soft. "We are," said the translated voice, "six billion light-years from home."

"Six . . . *billion?*" asked Thor, turning to face Jag.

Jag lifted his upper shoulders. "That is correct," he said, his voice still soft.

"That's . . . staggering," said Keith.

Jag lifted his upper shoulders. "Six billion light-years. Sixty thousand times the Milky Way's own diameter. Twenty-seven hundred times the distance between the Milky Way and Andromeda." He looked at Keith. "In terms you non-astrophysics types might use, one hell of a long way."

"Can we see the Milky Way from here?" asked Keith.

Jag made a gesture with his arms. "Oh, yes," he said, his barking still subdued. "Yes, indeed. Central Computer, magnify sector 112."

A border appeared around a portion of the holographic bubble. Jag left his workstation and walked toward it. He squinted for a moment, getting his bearings. "There," he said pointing. "That one there. And that's

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Andromeda next to it. And this is M33, the third-largest member of the Local Group."

Rhombus's lights twinkled in confusion. "Boundless apologies, but that can't be right, good Jag. Those aren't spiral galaxies. They look more like disks."

"I'm not mistaken," said Jag. "That is the Milky Way. Since we are now six billion light-years from it, we are seeing it as it looked six billion years ago."

"Are you sure?" said Keith.

"I am positive. Once the pulsars had told me approximately where to look, it was easy enough to identify which galaxy was the Milky Way, which was Andromeda, and so on. The Magellanic Clouds are too young for any light from them to have reached this far out, but globular clusters contain almost exclusively ancient first-generation stars, and I've identified several specific globulars associated with both the Milky Way and Andromeda. I am sure of it—that simple disk of star is our home Galaxy."

"But the Milky Way has spiral arms," said Lianne.

Jag turned to her. "Yes, without question, the Milky Way today has spiral arms. And, just as surely, I can now say that when it was six billion years younger, it did *not* have spiral arms."

"How can that be?" asked Thor.

"That," said Jag, "is a vexing question. I confess that I would have expected a Milky Way even half its present age to still have arms."

"OK," said Keith. "So the Milky Way gains spiral arms sometime in the interim."

"No, it is *not* OK," said Jag, his bark returning to its usual sharpness. "In fact, it has *never* made any sense. We've never had a good model for galactic spiral-arm formation. Most models are based on differential rotation—the fact that stars near the galactic center make several orbits around the core in the time it takes for those farther out to complete just one. But any arms that resulted because of that should be temporary phenomena, enduring at most for a billion years. Oh, we should see *some* spiral galaxies, but there is no way that three out of every four large galaxies should be spirals—which is the ratio we actually observe. Ellipticals should far outnumber spirals, but they do not."

"Obviously, then, there's a flaw with the theory," said Keith.

Jag lifted his upper shoulders. "Indeed. We astrophysics types have been limping by for centuries with something called 'the density-wave model' for explaining the abundance of spiral galaxies. It proposes a spiral-shaped disturbance that moves through the medium of a galactic disk, with stars getting caught up in it—or even being formed by it—as the wave rotates. But it has *never* been a satisfactory theory. First, it fails to account for all the different types of spiral forms, and, second, we don't have a good answer as to what would cause these imagined density waves in the first place. Supernova explosions are sometimes cited, but it's just as easy to model such explosions canceling each other out as it is to get them to build up long-duration

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waves." He paused. "We've had other problems with our galaxy-formation models, too. Back in 1995, human astronomers discovered that distant galaxies, observed when they were only twenty percent of the current age of the Universe, had rotational rates comparable to what the Milky Way has today—that's twice as fast as they should have been rotating at that age, according to theory."

Keith thought for a second. "But if what we're seeing right now is correct, then spiral galaxies like ours must somehow form from simple disks, right?"

Another lift of the Waldahud's upper shoulders. "Perhaps. Your Edwin Hubble proposed that galaxies each start as a simple sphere of stars, gradually spin out into a flat disk, then develop arms that open up more and more over time. But although we now have observational proof that that sort of evolution does indeed happen"—he gestured at the disk of stars in the glowing frame—"we still don't have an explanation for *why* the evolution takes place, or why the spiral structures persist."

"But you say three-quarters of all large galaxies are spirals?" asked Lianne.

"Wellll," said Jag, PHANTOM translating a hissing bark as a protracted word, "actually, we don't know much directly about the ratio of elliptical to non-elliptical galaxies in the Universe at large. It's hard to make out structure in dim objects that are billions of light-years away. Locally, we see that there are many more spirals than there are ellipticals, and that spirals contain a preponderance of young blue stars, whereas our local ellipticals contain mostly old red stars. We've assumed, therefore, that any vastly distant galaxy that showed lots of blue light—after correcting for redshift, of course—was a spiral, and any that showed mostly red was an elliptical, but we really don't know that for sure."

"It's incredible," said Lianne, looking at the image. "So—so if that's how it looked six billion years ago, then none of the Commonwealth homeworlds yet exist, right? Is there—do you suppose there's any life in the galaxy now?"

"Well, 'now' is still 'now,' of course," said Jag. "But if you're asking if there was any life in the Milky Way back when that light started its journey to us, I would say no. Galactic cores are very radioactive—even more so than we used to think. In a large elliptical galaxy, such as we're seeing here, the whole galaxy is essentially the core. With stars that close together, there would be so much hard radiation everywhere that stable genetic molecules wouldn't be able to form." He paused. "I guess that means it's only middle-aged galaxies that can give rise to life; young, armless ones will be sterile."

There was silence on the bridge for a time, broken only by the gentle hiss from the air-circulating equipment and the occasional soft beep from a control panel. Each person contemplated the small fuzzy blot of light that one day would give rise to all of them, contemplated the fact that they were farther out in space than

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anyone had ever been before, contemplated the vastly empty darkness all around them.

Six billion light-years.

Keith remembered reading about Borman, Lovell, and Anders, the Apollo 8 astronauts who had circled the Moon over Christmas of 1968, reading passages from Genesis back to the people on Earth. They had been the first human beings to get far enough from the homeworld so that they could cup it in an outstretched hand. Maybe more than any other single event, that view, that perspective, that image, had marked childhood's end for humanity—the realization that all their world was one tiny ball floating against the night.

And now, thought Keith, maybe—just maybe—*this* image was the one that marked the beginning of middle age: a still frame that would become the frontispiece of Volume Two of humanity's biography. It wasn't just Earth that was tiny, insignificant, and fragile. Keith lifted his hand and reached out toward the hologram, cupping the island of stars in his fingers. He sat silently for a long moment, then lowered his hand, and allowed his eyes to wander over the overwhelming dark emptiness that spread out in all directions. His gaze happened to pass over Jag—who was doing exactly what Keith had done a moment ago, using one of his hands to cup the Milky Way.

"Excuse me, Keith," said Lianne, the first words spoken by anyone on the bridge for several minutes. Her voice was soft, subdued, the way one would talk in a cathedral. "The electrical system is repaired. We can launch that probe anytime you like."

Keith nodded slowly. "Thank you," he said, his voice wistful. He looked once more at the young Milky Way floating in the darkness, and then said softly, "Rhombus, let's have a look at what's going on back home." ■

TO BE CONCLUDED IN THE NEXT ISSUE.

He that would make his own liberty secure must guard even his enemy from oppression; for if he violates this duty, he establishes a precedent that will reach to himself.

—Thomas Paine

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The Tranquillity Alternative, Allen Steele, Ace, $21.95, 306 pp. (ISBN: 0-441-00299-4).
Inheritor, C. J. Cherryh, DAW, $21.95, 410 pp. (ISBN: 0-88677-689-9).
Looking for the Mahdi, N. Lee Wood, Ace, $12, 293 pp. (ISBN: 0-441-00298-6).
River of Dust, Alexander Jablokov, Avon/Morrow, $22, 326 pp. (ISBN: 0-688-14605-8).
Pirates of the Universe, Terry Bisson, TOR, $22.95, 285 pp. (ISBN: 0-312-85412-9).
Darwin: A Life in Science, Michael White and John Gribbin, Dutton, $24.95, 322 + xiv pp. (ISBN: 0-525-94002-2).
World-Building: A Writer's Guide to Constructing Star Systems and Life-Supporting Planets, Stephen L. Gillett, Writer's Digest Books, $16.99, 198 pp (ISBN: 0-89879-707-1).
Aliens and Alien Societies: A Writer's Guide to Creating Extraterrestrial Life-Forms, Stanley Schmidt, Writer's Digest Books, $17.99, 226 pp. (ISBN: 0-89879-706-3).
Proximity Zero (2nd Edition): A Writer's Guide to the Nearest 200 Stars, Terry Kepner, The Bob Liddil Group (P.O. Box 66, Peterborough, NH 03458), $19.95, 93 pp. (ISBN 0-926895-0404). Reviewed by Stanley Schmidt.

What we as a nation have chosen to do with our space program is a sad, sad tragedy and a mockery of the human spirit. Driven by Cold-War competition, blessed with a can-do spirit fanned by success in World War II, and armed with a willingness to take risks based on memories both of recent war and of times when ordinary life was a much riskier affair (we have had antibiotics for only five decades—and for only two when Mercury and Gemini and Apollo began their run), we went to the Moon. It took us only a little over ten years, from the *Sputnik* goad to "*Eagle* has landed." And then we quit. Been there, done that, blew a wad, and the hell with it. After all, somebody might get hurt.

We won the competition. "Can-do" ran into a good deal of anti-technology feeling fed by the Vietnam war and technological side-effects (accidents, toxic spills, routine pollution, etc.). We forgot that risk was normal. We decided pinching pennies was more important than creating the conditions for future prosperity or stoking the fires of national spirit. And now

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we buy from Japan products (e.g., VCRs) based on technologies invented here. If we're still Number One, the chest-pounding has a hollow ring to it.

That last bit is a little hyperbolic, but there is truth to it, and it's a truth that has drawn the attention of many science fiction writers ever since the US's withdrawal from space. One of these writers is Allen Steele, often touted as an heir to the Heinlein mantle, a strong advocate of space development, and a journalist with a decent eye for the world as it is.

A few years ago, he published several stories which supposed that the Germans built a spaceplane with which to bomb America. Our government put Robert Goddard to work and created a space program much earlier than in our real world. The result was an earlier Moon landing, a wheel-shaped space station, an actual base in Tranquillity, a manned landing on Mars. In other words, a history much like that the science fiction writers of the fifties were imagining, and the space-program engineers were planning.

Perhaps the key is simply the earlier start and a longer ride on that can-do momentum of World War II. If so, it seems quite reasonable to say that at roughly the same time, the enthusiasm should flag and the US should retreat from expense and risk, while other countries should step in. Perhaps it is even reasonable to suppose that the US would sell its space station and its Moon base to a private company, and a German one at that.

Given that, of course, there would have to be suitable ceremonies to accompany the handing over of the keys to the joint. The previous tenants would also have to clean the place up, removing such little items as the half-dozen nuke-tipped missiles emplaced near Tranquillity Base at the height of Cold-War paranoia.

This is the task that occupies Steele in **The Tranquillity Alternative,** though it is clear from the start that something is going dreadfully wrong. Dooley, the computer specialist who is in charge of launching the missiles into the Sun, is kidnapped, replaced by a plastic-surgeried look-alike, and tortured for all the necessary passwords. Cris Ryer, an astronaut whose lesbianism has just drawn notice and put her in bad official odor, is packing a computer disk with something ominous on it. Two German mission specialists. supposedly representing the company about to take over the US's major space assets, have plastic sidearms and a plot as well.

It takes awhile for anything to happen. Steele spends a great deal of time on setup, giving us plenty of background, including lessons in US history—details are different, but the overall thrust is much the same—and thorough descriptions of the hardware that has made his world's space program possible. He also assures those who have forgotten that almost every piece of hardware he presents was "invented in the 1950s and detailed in some keystone nonfiction works of that era."

In due time, of course, things happen very quickly and satisfyingly. But this component of the story may be

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almost beside the point to fans of the space program. His point is "What might have been," and perhaps even "What might yet still be" if we could just remember the values of risk and technological investment, recapture the can-do spirit, and pry our hands out from under our butts.

C. J. Cherryh's latest series began with *Foreigner,* which offered us a starship laden with the builders and residents of a planned Station, marooned in space, finding a planet inhabited by an intelligent species, the atevi. Two centuries before the story, some of the humans had come to ground while others had hied off in search of home. The settlers in due time ran head-on into profound differences between humans and atevi, who associated with each other according to perceptions of advantage and power, with no sense of human love or liking. That is, they were exceedingly political creatures; perhaps they were even Cherryh's attempt to present human beings without their usual façade of the "finer feelings." If so, they were a remarkably successful creation, for atevi and human fought a war based in essence on the conflict between those who insist on façades and pretenses and those who do not. The war ended with the creation of a system that kept humans and atevi separate yet provided an interface, the paidhi, a professional diplomat whose mission was to translate between the two and to convey human technology to the atevi.

The current paidhi, Bren Cameron, was Cherryh's protagonist. Through him she showed us the profound differences in outlook between the species, the possibility that a human could learn to see as clearly as an atevi, and the power of the human craving for those "finer feelings." Bren *likes* certain atevi; he even loves some. And he knows they just don't think that way.

The series' second volume, *Invader,* reinforced the theme by presenting a human effort to replace Bren with a more human-oriented paidhi, Deanna Hanks. Alas, Hanks did not understand the atevi and nearly destroyed all the good that Bren had done before she was finally kicked back to the human-occupied island. Meanwhile, those humans who had gone off in the starship had returned and asked for those on the ground to get into orbit to help repair, refuel, rebuild, and so on. And they weren't quibbling over whether the help they needed came from the humans or the atevi. Indeed, they were beaming the specs for shuttlecraft and the like down to both groups. They were even sending each group an emissary to learn language and culture and serve as translators and ambassadors, as paidhi.

Now here's the third volume, **Inheritor**. The atevi, who are quite astonishingly intelligent and can get their act together very quickly when they perceive appropriate advantage, are making great progress on building what they will need to get into orbit. There is political conflict, for not all atevi agree on just where the advantage truly lies, and the humans, through Deanna Hanks, are doing their best to encourage the tradition-

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alists and thereby keep the atevi inferior. They are also destroying the state department, cutting off Bren's contacts with superiors and family, and persecuting his family back home. Bren is thus under considerable stress, and the "ship paidhi" he is trying to train is not making things any easier.

The book develops slowly, for Cherryh quite reasonably feels obliged to recap the complex background, politics, and psychologies involved. Yet she gets to her point soon enough, and when she finally reveals why the starship's humans are in such a sweat to get the grounders into space, we see that humans can guide their behavior according to perceived advantage quite as rationally as any atevi. They have a problem for which it is well worth setting aside the human preference for pretense.

And it is of course quite true that humans can do that when they see appropriate advantage in it. We're a flexible species. A question worth asking is whether this particular kind of flexibility is an advantage. Cherryh doesn't say, but even though *Inheritor* ends on a very satisfied and satisfying note, there remains room for more in the series.

N. Lee Wood's first novel, **Looking for the Mahdi,** amply fulfills the promise of her shorter work. It also offers an interesting example of compatibility between spouses. She is married to Norman Spinrad, renowned for his caustic, cynical view of government (perhaps especially our own, for he lives in Paris), and she is just as caustic and cynical. Any politician who visits their household must feel like a block of wood caught between two chainsaws. Given such a chance, I imagine that Spinrad and Wood have a great deal of fun.

Mahdi opens in a network news operation, where Kahlili bint Munadi Sulaiman, once a hot-shot battlefield reporter, now a desk-tender, is called into the boss's office to meet a gent from the CDI (Wood's future CIA) and a fabricant.

What's a fabricant? It bleeds, it talks, it looks human. It even has a name: John Halton. But it was assembled from the DNA up as a bioweapon. And the CDI wants Kay Bee Sulaiman to take up her PortaNet and return to war-torn Khuruchabja. Of course, she won't really be there as a journalist, and Halton, even though he will be working the cameras, won't be her cameraman. Her mission—and she really is not allowed to refuse—is to deliver Halton to the local sheik, whom he will then serve as a bodyguard.

Naturally, things begin to go wrong immediately. As soon as Kay Bee and Halton reach their orbital hotel, someone adds to their mission by giving them a microflake, a computer memory device that can store vast amounts of information, and telling them they will be contacted.

As soon as they reach Khuruchabja, they are kidnapped by mysterious folks who want that microflake. Halton gets them out of that one, but it is clear that Khuruchabja is very much a Middle Eastern snakepit of hate and connivery based on assorted kinds of bigotry. And to be sure no reader misses her point, Wood hands Kay

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Bee her own share of bigotry: John Halton is a gorgeous guy, but he's a machine. He can't possibly have feelings. Can he? Well, he shows the reader his heart fairly early on, but Kay Bee takes awhile to see it.

What's stashed on that flake? I won't tell you, but I will say that Wood is posing a very serious question. In the Middle East, much of the eternal conflict is between the Haves and the Have-Nots. What is Had and Not-Had can be either natural resources (oil) or something else that also brings in wealth. Wood has noticed that Israel, for instance, has something very special in that latter line, and she suggests that if other countries could find or be given their own versions of it, the snakepit might begin to calm down.

Mahdi is at times rather windy in its backgrounding, but overall it moves well and leaves the reader feeling satisfied. I don't think it will win any awards, but I won't be surprised if Wood's next does. Keep an eye on her.

Alexander Jablokov's **River of Dust** posits not terraforming, but burrowing as the basis for Martian civilization. After centuries of excavation, the cities have a rather Gormenghastly feel, for the "buildings" stretch on forever, and what is a rooftop from one point of view may be a public square from another. Or perhaps Gormenghast is not the proper comparison. The feel is also of Escher, the scale is Brobdingnagian, and the politics are baroque. It's also fairly convincing as Jablokov presents his vision, beginning with a mine shut down by an anti-corruption campaign and a suddenly unemployed worker, full of bitter anger, trekking back to the zennish "Pure Land School" presided over by Rudolf Hounslow, would-be revolutionary.

Central to the action are the Passmans. Father Lon, High Chief Judge and Executioner, once was close to Hounslow. Now he is the establishment personified. Not surprisingly, Hounslow takes advantage of that unemployed worker by sending her to Passman with a symbolic message. More surprisingly, she decides to extend the message, to put Hounslow's ideals into action by assassinating the planet's Earth-appointed governor.

Passman's overshadowed and rivalrous sons Hektor and Breyten each seek some path to identity and stature. Hektor is a sub rosa columnist and a very junior member of the government whose career is trashed when he runs head on into the power of political mythology. Breyten moves toward Hounslow as tensions rise and the revolution seems imminent. Yet other people—Breyten's girlfriend, a member of the Vigil, Mars's political police; the gangs that run the corridors; and more—are doing their best to shape the forces in play, and they prove much more effectual.

Jablokov is immensely skilled, but I thought his characters and their actions often arbitrary. That is, they seemed to act more because someone (the author, of course) was jerking their strings than because of their own drives and responses. The strength of *River of Dust* lies mostly in its vision of what a dug-in Martian

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culture might someday be like, and there Jablokov has achieved something I suspect will be imitated by others for years to come.

Will anyone try to imitate Terry Bisson's **Pirates of the Universe**? I'm not at all sure Bisson is imitable, for he has a quite idiosyncratically cockamamie way of satirizing the world he sees.

Consider, for instance, his notion that in the future Disney-Windows will own a space station—acquired after World War III trashed much of the world and put the USA up for auction—and operate the hunts for vast bubble-like space creatures (or maybe bubble universes) on whose hides the world's economy will be based. Disney-Windows is enough to make one pause until the connection of entertainment and information gels as the ultimate in infotainment. Basing an industry on the pricking of soap-bubbles—that's journalism, at least as journalists sometimes claim to see it. An auctioned-off nation—well, OK, it's an idea that's been in the air ever since "privatization" was invented, and selling off a space station (and a moonbase) has already been used by Allen Steele, just in this month's column.

What about the creatures? They're called Peteys, but no one knows much about them. Certainly Gun doesn't. He's just one of the Rangers who unzips their skins, brings the treasure back to the station, and then goes back to Orlando to spend his off-time and pay in a virtual reality which he cannot remember, even in his dreams (the girl is copy-protected, you see). This time, however, something is wrong. He's on some sort of "Administrative Hold." He can't get his pay, and without money to pay essential fees he can't even find out why. And it sure looks like his ticket to the "Pirates of the Universe" live-in theme park is in jeopardy.

Once he treks back to his boonie home, where his family runs a ferry on the oil dripped and scraped out of a fleet of rusting auto hulks, he discovers that the problem involves his brother, a political prisoner who has escaped from prison. To get his money and regain his hope of "Pirates of the Universe" for himself and his childhood sweetie, he must sign away his brother's life. Yet he must also do what he can to save that life, even if it means turning the Universe inside out.

Bisson succeeds better this time than he did with *Voyage to the Red Planet*. I still don't always find his logic or his premises entirely convincing, but in *Pirates* he does keep my disbelief in suspension well enough to let me marvel at the virtuosity of his imagination.

Michael White (author of the Asimov biography, *An Unauthorized Life*) and John Gribbin (known to SF readers for both novels and science popularizations) have done two well received scientific biographies before, one on Albert Einstein and one on Stephen Hawking. Now it is Charles Darwin's turn, and in **Darwin: A Life in Science** they have supplied a very readable short review of the life of the man who has done as much as anyone

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to shape the modern mindset, the man whom philosopher Daniel Dennett dubbed "Saint Charles."

White and Gribbin make it very clear that Darwin's grand insight into how evolution works was no bolt from the blue. He had been prepared by a varied—even checkered—education and by a personality that, in his own words, was "not apt to follow blindly the lead of other men." It is thus curious, as White and Gribbin note, that the first edition of *On the Origin of Species by Means of Natural Selection* is by far the clearest and most accurate of the several editions Darwin prepared. What spoiled the later editions was his effort to meet the objections of others; later work has proved his critics wrong and his first thoughts right, nearly every time. The shortcomings were not in his theory but in the state of science of the time, to the point that White and Gribbin can say Darwin virtually predicted Einstein's relativity theory and Mendel's genetics by highlighting the gaps in human understanding those discoveries in due time filled.

White and Gribbin also note that Darwin would have been a renowned scientist even without natural selection. He was an insightful geologist and biologist who did worthwhile work in several areas.

Yet White and Gribbin are occasionally guilty of over-interpreting in their effort to affirm the Darwinian greatness. On p. 45, they quote Charles Darwin's grandfather Erasmus—botanist, poet, and even evolutionist—as referring to a "living filament . . . the cause of all organic life," and suggest that amounted to foreseeing DNA. I checked the *Oxford English Dictionary* and found that a figurative meaning of "filament" was "scrap" or "shred." I understand the urge that made them do it, but it does strike me rather like saying that any roughly T-shaped prehistoric rock marking is a forecast of the airplane.

Fortunately, there are not many such spots. Overall the book is perfect for the lay reader who wishes to know a bit more about Darwin. It should certainly be in every high school and town library.

ANADEMS

An "anadem" is a garland. I use the term for a heading when I have something nepotistic to mention. Sometimes that means something of my own. Sometimes it means something by a writer closely associated with the magazine. This month it means books by editor Stanley Schmidt and longtime contributor Stephen L. Gillett.

Stan's is **Aliens and Alien Societies: A Writer's Guide to Creating Extraterrestrial Life-Forms**. It's designed for writers, especially beginners, and it provides a great deal of useful information from biology, sociology, linguistics, and more, along with references to sources, commentary, and examples, often from Stan's own stories. If writers pay attention, it should do a great deal to improve the quality of the slush-piles every editor in the business must wade through every day.

Gillett's is **World-Building: A Writer's Guide to Constructing Star Systems and Life-Supporting**

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Planets, and it does much the same job, with much the same intent, for geology, geophysics, astronomy, and related fields. His style is different, though, more like a textbook, less discursive, less given to examples from his own and others' fictions. Of the two, this one may be more worth keeping on a writer's shelf for its tables of data and instructions on calculating tidal forces, seasons, orbits, and so on.

There is some overlap between the two books. That's inevitable, for aliens are what they are because of the environments in which they live. But they are different enough that every would-be SF writer should surely buy the pair. And the writer should also keep an eye on the bookstore shelf, for these books are the opening shots in a series, edited by Ben Bova, on writing SF.

Taken together, these books may be just as valuable to teachers as to writers. They provide a concise and readable overview of what we know about the living and nonliving world, and their very best use may well be as science texts in a middle-school "Writing across the Curriculum" program.

In 1994 Terry Kepner performed a valuable service for any science fiction writer who wants to set stories on believable planets of stars within 40 light-years of our Solar System. His *Proximity Zero* was a little gem of a reference book providing a succinct introduction to stellar astronomy plus star maps, exact locations, and detailed descriptions of all the stars within that sphere—with particular emphasis on how each star's characteristics would influence what kinds of planets might exist around it.

One thing was missing. If you're writing a story that involves travel between stars, or contact between beings evolved around them, you'll often need to know how far apart the two stars are. *Proximity Zero* provided enough data to figure it out for any pair of stars in its sphere of coverage, but the actual calculation was left "as an exercise for the reader." Now Mr. Kepner has done the calculation for you: the new edition contains everything that was in the original, plus a lengthy table giving the distances between all pairs of listed stars.

And if you already have the first edition and don't want to spend $19.95 for a new one that is partly a duplicate of what you already have? The distance table is available separately as a 36-page supplement, titled *Proximity One,* for $9.95. ■

The man who can make hard things easy is the educator.
—Ralph Waldo Emerson

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BRASS TACKS

Dear Stanley:
While I enjoy all of *Analog*, I especially applaud your consistently sensible and clearly written editorials. It's reassuring to hear someone else standing up for ideas that are not popular in the mainstream.

Your February editorial on population growth spurred me to add these thoughts of my own. We often hear in the media how the fastest growing population segment below the poverty line is children. This is reported with sadness and horror, and followed by urgent plans to "help the children."

While I certainly believe in children receiving adequate food, shelter, medical care, etc., I believe the only effective way to "help" them is to find out why they are becoming poor, and prevent it.

Now, children are not independent economic units (unless they are abandoned or runaways). They do not sink into poverty while their parents stay solvent. A household is an economic unit. If households containing one or two adults and one or two children were slipping into poverty, then the adult-child ratio would stay relatively steady. If we are seeing growth in the segment of poor children, then something else must be happening.

There are a few possibilities. One is that the families slipping into poverty have many more children than adults. Could there be a causative relationship here? Might families with fewer children have a better chance of staying solvent?

There may be a huge increase in abandoned or runaway children. Children are abandoned because parents are not financially or emotionally able to care for them. Children run away for many reasons, but the ones that stay on the streets and don't return home may do so because "home" is even less desirable than the poverty and danger of the streets. For both abandoned and runaway children, the parent(s) were not properly equipped to have and raise children.

Finally, there may be a growth in children below the poverty line because mothers below the poverty line are having more babies than those in better financial circumstances. This is a self-sustaining cycle, since the more children there are in the household, the harder it is for the household to rise above poverty. Children require large amounts of time and money, and they contribute nothing financially to

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the household (unless you count AFDC, another can of worms).

There seems to be a common solution for all these causes of children in poverty: people at the lower end of the financial spectrum should delay and limit the number of children they have. Delay it until they can acquire the skills and income to support the children. Limit the number so they don't turn a successful family of four into a failing family of eight or ten.

The best way to do this, as you stated, is the hardest: with education. This must be coupled with an effective program to give these people the tools (education, confidence, skills, etc.) to raise and sustain their financial status, and live independent of government or charity support. Any government money spent actually turning people into productive self-supporting citizens is well-invested. The government will make the money back, with interest. This is not the same as a mere maintenance handout.

Unfortunately, we (as a people) have turned motherhood into a sacred cow that must not be disturbed in any way. We regard the right to have a baby—at any time, under any circumstances, and as often as desired—to be an inalienable God-given right. To even suggest thinking about practical issues and delaying or curtailing childbearing is regarded with horror and accusations of Nazism.

Note, I am not advocating any forced birth control. I am advocating individual informed choice based on a sensible assessment of the situation. I would not advocate forcing something like Norplant on poor women. However, I would advocate making it freely available to them, along with counseling to help them develop a life plan for creating a household in which they would choose to have a baby, if they so desire.

If we don't come up with an effective program for education and population control by free choice, eventually we will be faced with forced population control, whether from a dictatorial government or from nature itself.

SHARI PRANGE

Santa Cruz, CA

Dear *Analog,*

"It wasn't my fault that I couldn't work a miracle." As a Critical Care Nurse at Santa Monica-UCLA Medical Center, I have often rerun events in my mind coming to that conclusion, but logic doesn't always abate the feelings of guilt.

Thank you for the story "Out of the Wasteland" by W. R. Thompson. (If you don't print my letter, can it be passed on to the author?) When Margaret thought, "Well intentioned monologues about grief and healing were torture," I remembered countless well intentioned monologues I have delivered to patients on ventilators and unresponsive. I do insist on unrestricted visiting by loved ones, encouraging them to talk to the patient. If the person has no visitors, I try to be with them and show my caring as Geisler did when he sat beside Margaret's bed. "He said nothing: he was just there, which was enough." Is it enough? At least if I try (usually

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the monologue is describing what is happening, "You have a breathing tube, that is why you can't talk. When you don't need it anymore, you will be able to talk.") I can have a clear conscience—after all, it's not my fault if I can't work a miracle.

I would like to give this story to other caregivers, the science fiction doesn't require too much background in terms of science fiction reading. It would also make an excellent television special. This story is an example of the best fiction can do. I would also like to give it to the patient, who didn't quit smoking, call 911 early or lose weight. They would have if they could. (I still try to give people the will.) Teachers, social workers, and parents also need this realization. I already knew this was true, now I realize it, too.

KATHY CARDER, RN, CCRN, BS
1026 Pleasant View
Venice, CA 90291

Dear Dr. Schmidt:

Please accept my sincere thanks for publishing the public service ad on page 74 of the March 1996 issue.

I have conducted independent research and can confirm that everything Coalition to Ban DHMO says is true. I did not know there was an organization fighting to deal with this problem.

I was prepared to write a check for $10,000 to support their efforts, but I had an emanation of DHMO from my ocular orifices while I studied this ad, as a result of a severe attack of jocundity. The DHMO fell onto my check and destroyed the ability of my pen to make a decipherable mark. This effect, crippling the economy of our nation, was not mentioned by the Coalition to Ban DHMO.

May I have permission to send a copy of this ad to the organization that is trying to get the government to remove chlorine from drinking water?

RONALD BALDWIN
3 Terry Lane
Newark, DE 19711

Dear *Analog*:

I thought the absurd "ad," "Ban Dihydrogen Monoxide," in your March issue (p. 74) was funny and a good poke at environmental extremists. I don't think that water will be banned anytime soon!

But this was not listed in your table of contents, and the address at the bottom looked real.

Isn't there some rule about making such things appear real (e.g., Orson Wells's "War of the Worlds" radio broadcast)?

Let us hope, for the few who might think this is a real ad, that the returned envelope contains an equally clever letter explaining the joke and chastising them for their foolishness—and not, as I suspect, a request for money.

Please encourage these foolish few to not, under any circumstances, send them any money!

ROLLIN JEGLUM
100 Powdermill Road #238
Acton, MA 01720-5912

Dear Mr. Schmidt:

G. Harry Stine makes a couple of

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good points in his reply to my letter in "Brass Tacks" (February 1996): I did not list my qualifications as an "art expert" and I did not address the central argument of his article.

I did not really think it necessary to qualify myself, as I did not really intend to offer a viable definition of art so much as to express offense at being told by Mr. Stine that his idea of beauty is an unspoiled appreciation of absolute beauty while mine, if it differs, is the unfortunate result of brainwashing. To be completely honest, I am not the least bit qualified to claim any art expertise at all. I have a college degree but have never taken an art course, nor read any books on the subject until today, and can count on one hand all the art museums that I have ever visited; so, while I am flattered to have my argument labelled "classic," it certainly is not "well-rehearsed."

Similarly, while I found the premise that beauty is absolute and independent of mutable human judgment—and that Stine recognizes true beauty while I cannot—to be offensive and worth writing about, I was altogether unmoved by what I perceived as his major thesis, the proposition that deviation from such an aesthetic will likely result in a deviation from traditional morality, a simple non sequitur not warranting much debate. Nevertheless, if Stine wants to swap quotations from Russian authors, let me offer Leo Tolstoy's "What a strange illusion it is to suppose that beauty is goodness" (*The Kreutzer Sonata* Ch. 5).

Oh, by the way, while I was at the library looking up that last bit I also looked into the artistic tastes of Adolph Hitler and into official Nazi policy regarding the arts. If Mr. Stine thinks that adherence to the traditional art aesthetic of the Renaissance is any guarantee of goodness and wisdom, then I've got some really, really bad news for him.

PERRY MILLER

3314 Birch Avenue
Bremerton, WA 98310

Dear Dr. Schmidt,

While reading G. Harry Stine's reply to Mr. Miller in the February 1996 issue, I came across a slight nit to pick.

In his paragraph discussing beautiful things that are obsolete, he mentions Raymond Loewy's designs of automobiles and steam locomotives. I must correct his impression that Loewy designed the shroud for the New York Central's Hudson locomotives. The last ten Hudsons emerged from the American Locomotive Company (ALCO) in 1938 with Henry Dreyfuss's styling of their shrouds. The NYC ordered their locomotives from ALCO, which was located online at Schenectady, New York, not from Baldwin.

Both the New York Central and the Pennsylvania placed orders in 1937 and 1938 for new equipment for their respective flagship passenger trains. The Central's *Twentieth Century Limited* and the Pennsy's *Broadway Limited* were both re-equipped with streamlined, lightweight Pullmans and streamlined locomotives.

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Raymond Loewy did the styling for the Pennsylvania and Henry Dreyfuss did the *Twentieth Century's* interior and exterior appointments.

Raymond Loewy also did the shroud for the Pennsy's K4s locomotive No. 3768. The 3768 did the honors on the first eastbound streamlined *Broadway* on June 15, 1938. More often than not, the *Broadway* received un-streamlined locomotives west of Harrisburg. East of there, the trains were pulled by the long-lived GG1 electric locomotives.

The first GG1 had an awkward riveted skin, and Loewy designed a smooth welded skin for the following 138 GGIs. The GG1 lasted in service into the Conrail era and the last one was retired during the '80s. Both Amtrak and Conrail used GGIs until they were replaced by (1) Amtrak buying newer electrics and (2) Conrail de-energizing its catenary and using diesels instead.

T. G. SHEARER

Homewood, IL

Dear Mr. Schmidt,

Quite enjoyed Robert Freitas's article, however believe his analysis of Transporters was a bit shallow. First, its only use (if restricted to inanimate objects) is to fax unique sculpture type objects. After all, if you have Replicators, there's no need to transport any manufactured or grown object from one place to another. (Incidentally, if you have a replicator, then large denomination paper money is seriously compromised. And you can't control replicators with mint equivalent security and remain competitive.

Of course, in the long run any material, non-energy, economy is seriously threatened by any nanotechnology.)

A Transporter is basically a people moving device, raising the question whether the travelers will arrive alive, dead, or more likely in a coma.

Considering that humans routinely survive heart stoppages of 3-4 minutes or longer, the 10 second transmission shouldn't be any problem for gross body structures, but can't help wondering how easy it will be to "reboot" the brain upon reception. Suspect that convicts sent one-way into exile will be first "passengers." Remember that the speed of light advantage only starts to outweigh the known trivial risks for conventional transport at very long distances which means space (unless you have a serious fiber optic web) which is hardly empty—what would you consider to be an acceptable noise level in your body?

JOHN L. TISSELL, CH. E.

tissejo@oocl.com

The author replies. . . .

I agree with most of Tissell's comments, though you really don't need transporters at all if you can upload a human consciousness into a nanotech "utility fog" (e.g. J. Storrs Hall, *Extropy* #13, 3rd Qtr 1994), embed duplicate mindware into an insapient clone at the receiver end, etc. Personally, I have the most trouble with the identity issue. In any case, the implications of this and other nanotechnologies will doubtless fill whole libraries of discourse in the years ahead. My purpose in the article was simply to illus-

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trate the tremendous range of technical possibilities, to get the mental juices flowing.

ROBERT A. FREITAS JR.

Dear Stan,

I happened to come across the enclosed pages from the 12/7/81 issue of *Analog* while looking for something else and thought it might be a good idea to take a couple of minutes out of my lunch hour to ask whether Ben Bova's idea about asking the U. S. Postal Service to issue a commemorative stamp in John W. Campbell's honor was ever taken up.

MICHAEL

South Pasadena, CA

"The enclosed pages" were a letter suggesting that interested readers write to their Congresspersons requesting the issuance of such a commemorative stamp. As far as I know, no such stamp has yet been issued, so a new round of letters might be a good idea. ■

BOB SHAW 1931-1996

Bob Shaw, a writer well known and active throughout his adult life in both the professional and fannish science fiction communities, died February 11, 1996, in Manchester, England, of heart failure. He was 64. Born in Belfast, Northern Ireland, he lived most of his life in Great Britain. Like several other writers, he entered science fiction through fandom; unlike many, he remained active there, winning two Hugos as Best Fan Writer, even while building an impressive reputation as a professional writer. In addition to many novels, including *Orbitsville* and *The Ragged Astronauts,* he is especially remembered for his *Analog* short story "Light of Other Days." Slow glass, introduced in that story, is one of the most strikingly original concepts in science fiction, but it was the *story* that, in a mere seven or eight pages, engraved itself indelibly in the memory of virtually anyone who ever read it. At the other end of Bob's very wide range were his "Serious Scientific Talks," some of the funniest things ever heard at a science fiction (or anywhere else).

Bob's first wife, Sarah "Sadie" Gourley, died in 1991 after almost 46 years of marriage. Some bad years followed, but in December 1995—less than two months before his death—he married Michigan fan Nancy Tucker and moved to the U.S. with her. Bob will be very much missed by all who had any contact with him, either personally or through his writing or talks; but our especially heartfelt sympathy goes out to Nancy.

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UPCOMING EVENTS Anthony Lewis

5–8 September
NORTHSTAR 1 (BC SF conference) at Richmond Inn, Vancouver, B.C. Guest of Honour: S. M. Stirling, Fan Guest of Honor: R. Graeme Cameron. Registration : C$65 at the door. Info: Box 61007, 571 West 57th St., Vancouver, BC V6P 6S5 Canada. Phone: (604) 951-7827. E-mail: Cathy_mayo@mind.link.bc.ca

6–8 September
COPPERCON 16 (Arizona SF relaxacon) at Holiday Inn, Scottsdale, AZ. Guest of Honor: Lois McMaster Bujold. Registration: $30 until 24 August, $35 at the door. Info: Box 82303, Phoenix, AZ 85071. (^02) 973-2054. E-mail: coppercon@aol.com

13–15 September
MOSCON 18 (Idaho SF conference) at University Inn Best Western, Moscow, ID. Guest of Honor: David Weber. Registration: $22.50 until 1 September, $25 thereafter. Info: Box 9622, Moscow, ID 83843. (509) 334-4434. email: moscon17@aol.com

14 September
FALCON (Nova Scotia SF conference) at Lord Nelson Hotel, Halifax, N.S. Guest of Honor: Robert J. Sawyer; Artist Guests of Honor: Peter Francis, Luisa Nadalini; Fan Guest of Honor: Michael Galland. Registration: C$10 until 14 August, C$12 at the door. Info: Box 36123, Halifax, NS B3J 3S9, Canada.

27–29 September
RISING STAR (Virginia SF conference) at Roanoke, VA. Guest of Honor: Frank Kelly Freas. Info: Dr. Fred R. Eichelman, 545 Howard Dr., Salem, VA 24153. (703) 389-9400.

Convention runners: If your convention has a telephone, FAX, e-mail, or Web page, please let us know so that we can publish this information.

Convention attenders: When calling conventions for information, do not call collect and do not call too late in the evening. It is best to include a S.A.S.E. when requesting information; include an IRC if the convention is in a different country.

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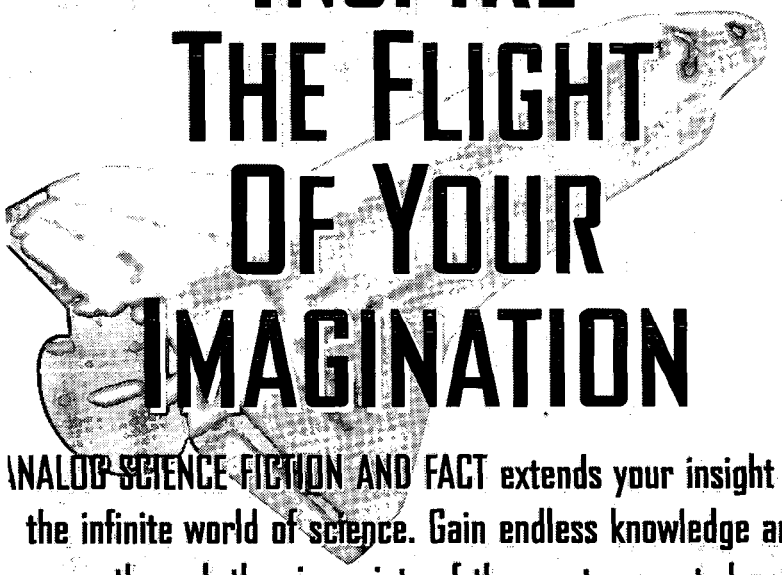

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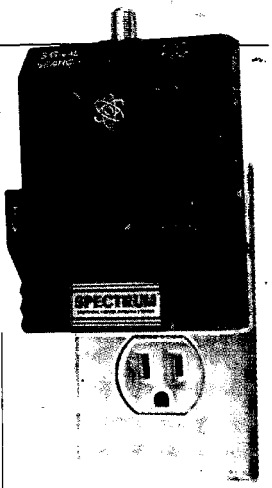
Fifteen years of microelectronic research makes conventional antennas a thing of the past!

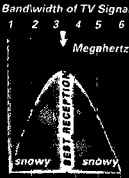
This little box uses your home's electrical wiring to give non-subscribers, cable subscribers and satellite users better TV reception on your local broadcast networks!

by David Evans



Technology corner

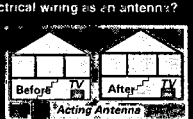
1. Why don't conventional antennas work as well as the Spectrum?



■ When TV signals are tuned at the TV channel's center frequency, optimum tuning has been achieved.

■ Other antennas can't offer center frequency tuning like the Spectrum Antenna can. They only offer such tuning up to the edge of the center frequency. As a result your TV picture remains snowy.

2. How does Spectrum use a home's electrical wiring as an antenna?



Believe it or not, the Spectrum Antenna simply "activates" the giant antenna that already exists in your home. Essentially, it uses all of the wiring throughout your home's walls and ceilings to make an antenna as large as your house for unbelievably clear reception of local broadcasting.

3. Spectrum antenna features

Parallel 75 ohm resistance
For maximum signal transfer

Signal search control
For precisely matching antenna to current signal

Polarized three-prong plug for grounding
For safety and to help reduce noise and static

Resonant fine tuner control
For optimum single-channel TV stereo reception and minimum crosstalk

Dual AC outlets with built-in surge protection
For plugging in additional TV stereo equipment

Until recently, the only convenient way to guarantee great TV reception was to have cable installed or place an antenna on top of your TV. But who wants to pay a monthly cable fee just to get clear reception, or have rabbit-ear antennas that just don't work on all stations? Some people just aren't interested in subscribing to cable. Or they may live in an area where they can't get cable and TV-top antennas aren't powerful enough. And what about those people who have cable or satellite systems but still can't get certain local stations in clearly?

Now, thanks to fifteen years of microelectronics research, a new device has been developed that is so advanced, it actually makes conventional antennas a thing of the past. It's called the Spectrum Universal Antenna/Tuner.

Advanced technology. Just imagine watching TV and seeing a picture so clear that you'd almost swear you were there live. Just plug the Spectrum Antenna into a standard AC outlet and plug your TV into the Spectrum. You can remove the unsightly clutter of traditional TV-top devices gathering more dust than television signals. Get ready for great reception. Your TV will suddenly display a sharp, focused picture thanks to its advanced design "Signal Search" and "Fine Tuner" controls.

Who can use Spectrum?

- ***Cable users-You have cable but you can't get certain local stations in clearly.***
- ***Non-cable users-You don't have cable and want the stations to come in more clearly***
- ***Satellite users-You have a digital satellite system but can't get local stations in clearly***

Uses your home's electrical wiring. The Spectrum Antenna is a highly sophisticated electronic device that connects into a standard wall outlet. The outlet interfaces the Spectrum Antenna with the huge antenna that is your home wiring network. It takes the electrical wiring in your house or apartment and turns it into a multi-tunable, giant TV reception station which will improve your TV's overall tuning capability. The results are incredible. Just think how much power runs through your home's AC wiring system—all that power will be used to receive your local broadcasting signals.

How it works. Broadcast TV signals are sent out from the local broadcast station (ABC, CBS, NBC, etc.). They interface with your home's AC power line system, a huge aerial antenna network of wiring as large as your home itself. When the Spectrum Antenna interfaces with the AC line, the signal is sent to its signal processing circuit. It then processes and separates the signal into 12 of the best antenna configurations. These specially processed signals route themselves into 12 separate circuits. The Spectrum Antenna includes a 12-position rotary tapping switch, the "Signal Switch" control, which gathers twelve of the best antenna configurations.

The "Signal Search" offers varying antenna configurations for the user to select from the best signals of all those being sent. The signal then passes through the Spectrum Antenna's special "Fine Tuner" circuit for producing crisp, clear reception.

Risk-free offer. The Spectrum Universal Antenna/Tuner comes with our exclusive 90-day risk-free home trial and a 90-day manufacturer's warranty. Try it, and if you're not satisfied, return it for a full "No Questions Asked" refund

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